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ABSTRACT

This study explored how science and scientists were produced and reproduced within the setting of a university biology department. Building upon recent work in anthropology of education and feminist science studies, the study examined the reflexive questions of whether increased women's representation in science changes science practice and whether changing science practice increases women's representation in science. The methodology was designed to examine both the contextual values and the constitutive values of science in the training of scientists. Results showed some ways in which these values were shifting as more women assumed places of leadership within the department. At the same time, in other ways, the presence of women did not seem to cause the types of changes that feminist science studies have hypothesized. In terms of changing practices leading to changing representation, some evidence was found to support this assertion and other evidence that this might not always be the case. These findings can be interpreted through the anthropological perspective of practice theory in which individuals are seen as exerting agency both within and against institutional structures. (Contains 47 references.) (PVD)

Running Head: THE IMPORTANCE OF CONTEXT

The importance of context in creating change: The case of a reform-minded biology department

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Abstract

This study explores how science and scientists were produced and reproduced within the setting of a university biology department. Building upon recent work in anthropology of education and feminist science studies I explored the reflexive questions of whether increased women's representation in science changed science practice and whether changing science practice increased women's representation in science. I examined both the contextual and constitutive values of science as they were negotiated and played out in the training of scientists in this setting. I found some ways in which these values were shifting as more women assumed places of leadership in the department. At the same time, I identified other ways in which the presence of women did not seem to cause the types of changes that feminist science studies have hypothesized. In terms of changing practices leading to changing representation, I again found some evidence to support this assertion and other evidence that this might not always be the case. These findings can be interpreted through the anthropological perspective of practice theory, where individuals are seen as exerting agency both within and against institutional structures.

Introduction

In this study I considered the teaching and practice of science in the Department of Biological Sciences at a large public university that I refer to as Great Plains University (GPU). The GPU Biology Department was selected for this study based on two criteria: 1) women were represented in positions of power and 2) there was an explicit commitment to improving the experiences of woman undergraduate science majors. Over a third of the tenured and tenure-track faculty in the department were women, including the department chair and several senior faculty, and there was a lively discourse underway at the time of the study about improving the experiences of women in the program.

Following Longino (1990), I examined the contextual values, the personal, social and cultural values which belong to the environment in which science is done, and the constitutive values, those rules that determine what constitutes acceptable science practice or method, that seemed to hold sway. In this way, I considered one of the claims posited by feminist philosophers of science, namely that changing the practitioners of science will result in changes to the practice of science (Harding, 1991; Keller, 1992; Longino, 1989). The study also sought to explore the ways in which equity was operationalized in a site that espoused gender equity in the training of future scientists and the degree to which these localized science practices were successful at promoting gender equity.

I frame these gender issues within the context of "authentic" science learning, learning about science through the act of participation in the doing of science in the company of experienced science practitioners. This approach to teaching and learning

science at the K-12 level has been advocated as a way to address the goals of the national science education standards (Barab & Hay, 2000; National Science Board, 1999; National Science Foundation, 1996; Rutherford & Ahlgren, 1990). By examining the context in which this authentic science learning took place, and by paying special attention to the role that individual students played in both conforming to and resisting the expectations placed upon them within this context, I was able to problematize some aspects of the question of the value of this model of science teaching. This critique of authentic science contexts is grounded in the scholarship of feminist science studies outlined in the following section.

Philosophical Background: Feminist Science Studies

Two distinct but related scholarly traditions explore issues of gender and feminist scholarship as they apply to science. The first has to do with the interplay of gender and science, for example, how scientific research is often conceptualized and practiced from an androcentric paradigm and worldview. The second perspective deals with women's representation and participation in science, whether increasing women's participation in science might change aspects of how science is practiced.

Gender and Science

Feminist philosophers of science, whose work addresses issues related to the interplay of gender and science, argue that the practice of science is androcentric (developed by men using a male frame of reference that has, over time, come to be seen as "normal" and "scientific"), objectivist, gendered, and set up so as to maximize the benefit to Western white men. For example, Harding (1991) has argued that biological

determinism has been used by scientists and non-scientists alike to support the gender status quo in both science and society whenever social movements threaten to destabilize that status quo. Other work in this tradition deals with how sexual differences between males and females have been conceptualized in various scientific theories, invariably to the detriment of women (Laqueur, 1990; Martin, 1992; Schiebinger, 1989). The relationship between gender and science has also been examined through analyses of gendered images and metaphors used in theorizing about topics that are presumably ungendered. Examples of the use of such metaphors in science practice can be found in such disparate topics as weapons of war (Keller, 1992), cytoplasm (Biology and Gender Study Group, 1989), and particle detectors (Traweek, 1989).

Another area of philosophical inquiry has explored the question of how gender issues affect our approaches to both methodology and epistemology in science. At the root of this debate is the issue of how conceptions of knowledge, questioning, and research design, often taken for granted in modern scientific practice, could be reconstituted and how this could, in turn, produce fundamentally different ways of conceptualizing and doing science. In terms of the issue of epistemology, two perspectives have emerged, feminist empiricism, which looks to incorporate feminist critiques into existing scientific knowledge (Longino, 1990; Nelson, 1990) and feminist standpoint theory, which argues that research starting from women's lives and perspectives is necessary to enhance the partial view of the world generated by typical androcentric epistemologies (Harding, 1991; Hartsock, 1983; Rose, 1983).

From a methodological perspective, examples of what a reconstituted, inclusive science (sometimes referred to as a feminist or successor science) might look like have

generally been drawn from the biological sciences. These examples are meant to demonstrate that methodology in science is often tied to the researcher's preconceived ideas and beliefs, and that different perspectives will lead to different preconceived ideas, different questions, and therefore, different approaches. The argument is not that having preconceived ideas about an area of study is wrong, but rather that it is inevitable, and must therefore be addressed in an open, honest and forthright manner. Thus, feminist philosophers have not claimed that women will do science "better" but rather that they will do science differently. New methodologies evolve when researchers from diverse backgrounds bring their own interests and beliefs with them and ask the questions to which they are drawn without fear that their work will not be accepted by the mainstream.

Women's Representation in Science

The second branch of feminist science studies focuses on representation and participation in science practice, and has generally been the purview of historians of science. On the one hand, work in this historical tradition has focused on trying to uncover "missing" women scientists, those who did, in fact, make contributions to the practice of science, but who frequently went unnoticed (Alic, 1986; Phillips, 1990; Rossiter, 1995; Rossiter, 1997). On the other hand, this work has focused on modern biographies of women in science, with special attention paid to the difficulties they faced as a result of their gender (Gornick, 1983; Keller, 1977; Sands, 1993). These authors have provided examples of how women who attempt to enter into science face a number of obstacles not faced by their male counterparts. For example, they discuss the importance of peer support and peer interaction as a key to success in the natural sciences, and how

women are often on the losing end of these peer interactions (Gornick, 1983; Keller, 1977; Tonso, 1999)

As a result of these studies, other researchers have undertaken to look at how females practice science, and how their practice may differ from the ways that males practice science (Haraway, 1989; Harding, 1989; Hrdy, 1991; Keller, 1985). One of the central questions is whether a feminist or successor science (practiced by women or men) would look different than science as currently practiced. Any consideration of differing practices must examine both the context of discovery (the questions that get asked and don't get asked), and the context of justification (how scientific practice is carried out in terms of the methods of data collection and data analysis used). As Haraway (1989) pointed out, the feminist perspective on science is not limited to a greater sense of empathy and identification for female members of other species. This perspective is also about the "privileging of non-reductionist modes of knowing that insist on complexity and non-binary, interactionist relationships of the subjects and objects of knowledge" (pp. 316-7). Thus, the goals of feminist studies of the natural sciences have included efforts to destabilize the notion of how gender is constructed in scientific research and attempts to restructure the science/gender system, but also include the broader goal of creating new approaches to the practice of science that can be accepted in the mainstream culture of science.

Bridging the Feminist Science Studies

Recently, scholars have considered how the two aspects of feminist science studies described above, research on gender issues in science and research on women's representation in science, relate to each other (Kohlstedt & Longino, 1997). For example,

Rossiter (1997) claimed that examining a particular field of science in a particular time and place is critical to understanding how gender issues are linked to participation and demographic trends. She argued that the number of women and the positions they hold in a given field are important determiners of whether younger women consider this field tenable. Similarly, Kleinman (1998) has argued that the persistent image of the prototypical scientist as a Western white male served to act as a filter, limiting girls' and women's ability to see themselves as successful scientists. As Kleinman claimed,

> In the past and today, some women have been reluctant to pursue science because of the sex stereotyping of these activities. The widespread perception of science as male or masculine is one of the greatest barriers to adolescent girls who want to be seen as 'normally feminine.' (p. 841)

When brought together, these philosophical and historical perspectives on women in science provide a clear picture of how women have historically been excluded from the practice of science, as well as how women's approaches to science practice have been excluded from the process of science. These arguments imply that increasing the representation and participation of women in all the fields and sub-fields of science should result in a scientific practice that is different in terms of gender issues, gender metaphor, epistemology and methodology.

As more women have entered scientific fields in recent years [Rossiter, 1995 #67; National Science Board, 2000 #194] some have argued that these issues are already being adequately resolved and should no longer be seen as a major concern. (Gross & Levitt, 1994). Schiebinger (1997) has argued, however, that the recruitment and retention of women is science is far more complicated than just addressing the questions of academic preparation and equal opportunity employment. Insights from the studies of gender and science and women's experiences in science also need to be considered. Every woman's

experiences in the practice of science must be regarded as unique. The barriers and hurdles that convince some women to abandon science are surmounted by other women and are actively resisted by still other women (Seymour & Hewitt, 1997). As Kohlstedt & Longino (1997) stated,

> Many women scientists ignore or do not resist the gendering practices that surround them, while others are acutely sensitive and resistant, and still others manage to be conscious of but successfully negotiate the treacherous gender shoals in which they work. (p. 12)

This variety of responses to science, as practiced in a given time and space, is a theme that is central to my study, and one that serves to connect the feminist science studies to the anthropological perspectives that guided both my methodology and my conceptual understanding of how to interpret my observations.

Description of the Study Site

GPU was a large public university on the Great Plains. At the time of the study, the Department of Biological Sciences was both one of the largest departments on the campus (with nearly 1000 majors) and one of the fastest growing. While the number of full-time faculty (26) was growing as well, it was not keeping pace with the increase in students. The department was housed in a large, three-story building where all faculty had their offices and research labs on the second and third floors. Most of the lecture courses and all of the lab courses offered by the department, as well as most of the informal gatherings and meetings of both faculty and students, took place on the first floor of the same building. This arrangement of physical space allowed for the development of fairly strong identities as "members" of the department for both faculty and students who wished to be included in such membership. Because I spent two days a

week for nearly a year collecting data in these spaces, I gradually came to be seen by some as a member of the department.

As mentioned in the opening paragraph, I selected this site for my research based on two criteria, the representation of women in positions of leadership, and an explicit commitment on the part of some of those leaders to consider ways to improve the experiences of women in the department. Within the broader setting, I spent the majority of my time in one research lab, several classes, one life-science club (Pre-Med) and the departmental undergraduate and graduate students lounges. I selected the particular research lab (Sue's lab) as one focus for my study, based on three factors: a recommendation from the department chair, Sue's initial interest in the topic of my study, and the lab's location as part of a "pod" of five other research labs. I selected the classes I "audited" based on conversations with students and faculty and I selected the club based on the participation of students with whom I was already interacting.

Methods

Though conceptualized from a feminist philosophical perspective, my study was empirical, using questions and methods taken from cultural anthropology, namely, from an emerging theory of culture known as practice theory, described in the section following this one. I set out to study a culture whose knowledge, skills, and traditions were unknown to me and began the study with a focus on the anthropological constructs of categories of membership, social spaces, institutional structures and cultural productions. Fundamental to my data collection was my role as participant observer, in which I sought ways to be viewed by others as a participant as well as an outside

observer. I volunteered as a lab technician two days per week in Sue Phillips' research lab, and I also audited several undergraduate biology courses.

I wrote field notes while in the study site whenever possible and expanded upon them after leaving the site each day. I also conducted ethnographic interviews styled after Spradley (1979) and Erickson (1986). These interviews were only conducted after significant time had been spent in the field and were meant to verify or reject hunches and to help make sense of prior observations. Finally, document collection related to work in the study site (e.g. flyers, lab notes, memos, course handouts) provided valuable data to supplement participant observations and ethnographic interviews.

Data were analyzed recursively during and after the period of data collection, using Spradley's (1980) semantic structure analysis and through vignette analysis patterned after Van Maanen (1988) and Graue & Walsh (1998). Semantic structure analysis provided a highly structured and systemic approach to analyzing ethnographic data through a three-step process of domain analysis, taxonomic analysis, and componential analysis. In contrast, vignette analysis allowed for a more holistic and interpretive look at the data.

Practice Theory

The conceptual framework that helped shape the questions I asked and the ways I analyzed and interpreted my data was grounded in theories of practice that serve to move the culture concept in new directions such as: 1) the socio-historical development of cultural groups and their members over time (Levinson & Holland, 1996); 2) the interplay of social reproduction and cultural productions (Levinson, 1996); 3) power

relations within and across cultural groups (Luykx, 1996); and 4) the dialectic between structural (macro-level) features and individual agency (Eisenhart & Finkel, 1998).

Practice theory explores how individual identities and group cultures are formed in practice, within and against larger societal forces and structures. These social structures provide the (tacitly understood) frameworks that govern the functioning of social institutions, specifically in the present case, a university biology department.

By focusing on the dialectic between structure and agency, practice theory gives equal weight to macro-level structures (i.e. gender, class, race) and micro-level factors (i.e. an individual's every day practice). From this perspective, culture is seen not as a set of characteristics, but rather as a process, continually being constructed in practice. Individuals are not seen as passively accepting the conditions in which they live and function. Instead, they are viewed as having agency to counter the determining structures, though they must still do so while functioning within those structures.

Through agency, individuals may help to create a different vision for the culture in which they function, and ultimately, act on that vision in ways that challenge the status quo. However, at the same time, there are pressures on the individual to conform to the culture as currently practiced. Thus, in terms of the present study, the definition of a "typical" scientist or science student can be contested along structural lines (gender, class, race, age, etc.) and gradually changed, while at the same time there are real pressures placed upon the individual to conform to traditional scientific and student identities and additional costs to be paid for resisting those norms. This interaction can be viewed as a tension between social reproduction and cultural production, such as Willis (1977) described in his seminal account of why working class British boys entered the

same kinds of blue-collar jobs as their fathers. Like Willis' "lads" who chose to resist the norms of school and conform instead to the norms of the blue-collar factory workers they wished to become, women working in the GPU research labs often resisted the culture that would lead them to become researchers themselves, choosing instead to pursue biology-related careers that were considered less prestigious.

Findings

The theories of practice described above provide a useful lens with which to consider the feminist science studies from an empirical perspective. For instance, Kohlstedt's (1997) claim about the range of women's responses to science as practiced in a given time and space, can be viewed in terms of participants' conformity and resistance to these practices. In the following sections, I interweave this anthropological perspective to the two sides of the feminist science studies outlined above, the issue of the gendered nature of science and the issue of women's representation in science.

I begin by looking at the evidence in support of the claim that having women present and successful in the GPU biology department changed the way biology was practiced in this setting. Second, I present the counter-evidence exploring ways in which increased women's representation did not seem to have influenced the way biology was practiced at GPU. Third, I look at the issue of whether changing how science was being practiced in this setting had an influence on women's willingness to be active participants in these practices. Finally, I present some interpretations of how women in the GPU biology department both conformed to and resisted the forces that shaped their professional environment.

Women's Presence Changing the Practice of Biology

Kelly, Carlsen, & Cunningham (1993) have claimed that most sociological and anthropological studies of science practice have focused on the constitutive values of science, concerning themselves with questions of how scientific claims were constructed. Kelly et al. suggested that one of the ways in which the feminist science studies could add to this knowledge base would be through studies that examined the contextual values of scientific practice.

Contextual values

If the increased participation of women were having an effect on the contextual values of how biology was practiced at GPU, then I would expect to see different patterns of behavior in those labs spaces where women were well represented. During the year of my fieldwork for this study, I developed the habit of walking several times a day through the various labs in the wing where Sue's lab was located. . Sue's lab was part of a pod of five labs that encircled a central area housing shared equipment. Generally, twice every day that I was in the lab, once in the morning and once in the afternoon, I would make the circle, strolling through the different labs, greeting people and making observations as to who was doing what and where.

Initially, Sue's lab was not noticeably different from the other labs in the pod. The labs were all roughly the same size, tended to have the same basic types of equipment, and usually had roughly the same number of workers engaged in many similar tasks. There were, however, a few differences that I began to see over time between Sue's lab and the others in terms of the use of space. For example, while in some labs in the pod, bench space seemed to be strictly assigned, with the same people always working in the

same spaces, in Sue's lab, use of space was more fluid – people did tasks wherever there was space. The following excerpt shows an example of strictly controlled work space in another lab in the pod.

> *For the last three weeks the picture of Peter's lab at 9:30 has been nearly identical. Zhao is always in the first bay at the first bench looking at slides under a microscope. Zack is always in the second bay at the far end transferring fruit flies from one Petri dish to another. Neil, the undergrad work-study, is always in the second bay at the second bench mixing fly food, and Gary is always in the second bay across from Neil, sipping coffee and scrutinizing a lab notebook. Today, however, something is different and apparently amiss. As I walk by, Zack is complaining loudly.*
>
> Zack: You moved my plates before I had a chance to label them and now they're totally out of order! Three day's work down the drain!
>
> Zhao: I needed somewhere to lay out my gels and you left the plates out overnight and took up the whole bench. How was I supposed to know that they weren't labeled?
>
> Zack: Well, you could have just looked and seen that they weren't labeled.
>
> Zhao: Hey, it's not my job to check up on your work.
>
> Zack: I'm not asking you to check up on my work: just don't move my stuff next time!
>
> Gary: (coming back into the lab with a fresh cup of coffee) Do you think we could try to have a little less bickering and a little more cooperation please? We *are* all working on the same project, aren't we?.... (field note set # 12; 2/25/99)

This example points to both the competition for bench space that frequently occurs in research labs, as well as the avid defense of territory that is the usual result of this competition. This territoriality of research space has been documented in other lab studies, most notably by Traweek (1989). In a previous lab study (Buxton, 1999) I found that a lab with a significant concentration of women undertook several changes in the use of lab space that served to reduce territoriality and competition for space. These changes included the creation of more communal space, a willingness of individuals to occupy less space than they was entitled to based on rank or seniority, and attempts to accommodate the needs of others in terms of space and supplies, even when those others did not have a clear claim to the space or materials in question.

In the present study, I noticed a similar pattern of behavior in Sue's lab. For example, the following field note excerpt shows a use of space that was quite different from the above description of territoriality in Peter's lab.

> *When I came back from class, Clark, an undergraduate in the lab, was laying out a bunch of petri dishes and adding a nutrient broth. He had run out of space on his own bench and still had a bunch more dishes.*
>
> Clark : (to Virginia, a graduate student) Hey, can I push you out of the way to lay out the rest of these?
>
> V: Yeah, ok, let me just move my tomatoes.
> Virginia begins to put the tomatoes from which she was extracting seeds back into a basket.
>
> C: I don't mean to interrupt what you're doing.
>
> V: Oh, I can do this anywhere, and you should probably keep all your plates together.
>
> C: It would help.
>
> V: I'll just come over here and bug Marcy and Cory. I'm sure they won't mind. Can I move your rack, Marcy?
>
> Marcy: Sure, but be careful. We spent all morning concentrating those samples. (field note set # 6; 2/2/99)

During the course of my study I documented numerous examples of this kind of behavior in Sue's lab. Sue expected that even though space in the lab was tight, everyone would accommodate each others' needs. Another example of how different contextual values guided the ways women went about designing research in this setting can be seen in elements of the large National Science Foundation (NSF) grant proposal that Sue was working on during the entire second semester I was in her lab. While much of what made this grant proposal (an interdisciplinary approach to understanding pistil-pollen interactions in maize) unusual is a shift in constitutive values of how science is done, at least part of the difference involved a shift in contextual values as well. For example, of the three proposals submitted under this RFP by members of the GPU biology department, only Sue had assembled a team of researchers from across institutions and

across disciplines in order to investigate the selected problem in a number of different ways. Sue described her approach to the proposal in the following way,

> So you all know that I have these ideas about pollen-pistil interactions and I've been working pretty much non-stop on this proposal for the past two months. So I started contacting a lot of people to see who would be interested in pursuing this work with me. And I came up with three other people who are molecular biologists like me, Chin, Rosenberg and Thomas. But then I started thinking that I didn't want us to be just a bunch of "cloners" so I tried to get two other people to make us more well-rounded. So I got Phil Houser, who is a renowned plant cell biologist, really well known nationally and internationally. You'll notice that he's the only male on the project, He's been very supportive of all of us over the years including with things like tenure problems for those of us who are women and have had more than our share of problems over the years. Then there's Sally Luther, who's more of an anatomical biologist not molecular like the rest of us but she's really a deep thinker and both she and Phil have done a lot that relates to these pollen-pistil interactions. (field notes #10; 2/16/99)

This discussion highlights a way of thinking about scientific research that is aligned both with the philosophical positions outlined earlier in this paper and with the constitutive values expressed by Sue and other women in the department in the next section. Just as striking about this example was Sue's willingness to do the vast majority of the actual grant writing over the period of several months without asking for any greater part of the proposed funding or any greater leadership than any of the other four co-PIs.

> The biggest challenge in writing the grant was probably that I needed to show how we would tie the labs together. How would we share ideals and what would our collaboration look like? Each PI will have one major piece to focus on and them we'll have to get together periodically to hash out what it all means. We are planning an annual conference here at GPU which everyone involved in the project will attend and of course everyone here who is in the lab is welcome to come. Then also each lab will send one post-doc or grad student for two weeks to each of the other labs involved, once each year to learn the techniques that are specialized in that lab. I'm going to be jealous of whoever gets to do that because you'll get to learn some really awesome techniques. (field notes #10; 2/16/99)

This willingness to collaborate in ways where power and control were distributed pointed to a shift in contextual values that was taking place in the biology department at GPU. This can be viewed in contrast to the following comment made by a faculty member about the difficulty they have had in the past of convincing women to follow the path of academic research science.

> One problem is that nobody ever tells our students just how very competitive parts of science are. I think this competitive nature is generally bad, and especially bad for women because, on the whole, we don't like competition that much. At least not the kind of cut-throat professional competition that often exists in research science in areas like grant funding. It just isn't a comfortable environment for women. We'd just rather work together to do something. And so the whole way that science is set up in this competitive racetrack kind of experience really makes it not very appealing to a lot of women once we get into it. We just don't really feel at home here. But things are happening in our department to change that a bit, at least in our day-to-day work environment. In the big picture though, it's still pretty cut-throat. (Betty interview, 3/8/1999)

In the above two excerpts, Sue and Betty both acknowledge ways in which the context of how biology was being practiced at GPU was changing over time as women began to take on leadership positions. However, while Sue and Betty provided examples of changes that were well-aligned with the claims made by the feminist philosophers of science, it is dangerous to generalize too much from these two cases. From the practice theory perspective, identity is constructed within and against one's social setting and as a result, all individuals conform to local norms in some settings and resist those norms in other settings. Although some have argued that women will practice science in certain ways that differ from the practices of their male counterparts, the reality is more complex.

As evidenced from my data, not all women in the GPU biology department were guided by the same contextual values. For example, Phyllis, the department chair, was

characterized by others in the department as "having a masculine style of leadership," as "not afraid to throw her weight around," and "as competitive as they come." Some found her forceful and assertive style of leadership to be a plus, while others saw it as a source of difficulty, however, almost everyone agreed that she was an effective leader. By presenting herself in this way Phyllis was able to successfully lead a predominantly male faculty. At the same time, however, there is evidence that Phyllis was paying attention to the needs of her female faculty and female students. Her commitment to ensuring women received equal treatment in hiring and promotion decisions was demonstrated by the case of Sue's hiring. Sue's was the first new faculty search taking place under Phyllis' leadership, and as Sue related it,

> I had a new baby at the time I came to interview for the position, and my husband and the baby came with me. After the first day of the interview I was informed by several male faculty members on the search committee that even though I seemed like a strong candidate, the department had a policy of not hiring new mothers because it was "not fair to them to be placed under that kind of stress when they needed to be attending to their child." I couldn't believe I was hearing this. I mean, I thought they were kidding at first, but then I realized that they were serious. Luckily for me, Phyllis stepped in and informed the search committee that "on her watch," such personal factors were no longer to be considered in selecting the best person to fill the job. (field notes # 5; 1/28/99)

Phyllis' attention to the needs of female students could likewise be seen in her concern about building a greater sense of community in the undergraduate biology program, and her belief that such a climate would improve students' (and especially female students') experiences as biology majors. Thus, while there was no one way in which the presence of women in positions of leadership changed the contextual values that governed the practice of biology at GPU, general patterns emerged. These patterns dealt with collaboration, the sharing of space and resources and the creation of a mutually

supportive and welcoming environment, all characteristics that have been recognized in the feminist science studies. The changes in the contextual values of biology practice that seemed to be linked to the increase in women's representation in the department were also connected to changes in constitutive values.

Constitutive values

In analyzing how the increased representation of women in the GPU biology department influenced the constitutive values of science practice in this setting, I considered the rules that seemed to determine what counted as good science. The specific setting where I had the most direct interaction with science practice was in Sue's lab, but I was also able to make some observations in other labs.

Sue's grant proposal, described in the last section, set out to challenge the androcentric assumption that the male pollen grain was the only active participant in the pistil-pollen interactions that led to maize fertilization. This seemed to be a "textbook" example of what the feminist science studies argue that biology practice, strongly influenced by women's approaches to science, would look like. The degree to which this proposal was atypical in the department was also an indication of the persistence of reproduced norms of science practice in this setting. First, the particular problem that Sue was interested in – moving away from accepted views that assumed that the male element (the pollen) was responsible for doing all the work in fertilization -- was quite different from the other two proposals submitted by department members under the same RFP. As Sue described it,

> The pollen cell has to grow really far and it seems like the transmitting tissue is feeding the pollen tube and is also providing directions to it. There is lots of cell-cell communication going on in this interaction and

> the goal of the group will be to try to understand this communication. Within the group we each have different areas of expertise related to this topic. We are proposing to use plants that we already work with and to build on our knowledge of these. We have a lot of this between the six of us in tomatoes and maize which are both in the top 10 plants world wide in acreage. (field notes # 10; 2/16/99)

Sue's belief that the pistil (female organ) played a much more active role in cell-cell reproductive interactions than has previously been assumed put her work squarely within the genre of life science scholarship that has been written about in the feminist science studies (Biology and Gender Study Group, 1989; Haraway, 1989; Harding, 1989; Hrdy, 1991). These studies looked at women's research that helped to redefine female roles in reproduction, pointing out that male scientists have tended to overestimate the importance of male organisms in the reproductive process and underestimate the importance of female organisms (or in this case, female organs within plants).

Additionally, Sue's interest in functional genomics and figuring out what specific genes actually do, rather than just what the sequence of the genes is, also separated her work from some of her male peers in the department. Finally, unlike some other female scientists, who have denied claims than their work reflected their gender, Sue was willing to admit, albeit with some hesitation and caveats, that she felt that there were in fact differences between how men and women practiced science.

Sue: I'm sort of familiar with some of these ideas [feminist science studies] kind of in passing. The whole idea about intuitive science, I think it's a little dangerous and I guess I'm unwilling to generalize too much about how women do science that's different from men. But I do think there is evidence that women publish fewer papers but that they are of higher quality in the sense that they get referenced more. So maybe I think that women are more meticulous.

Me: Could you maybe give me some example of this?

S: Well, Phyllis may be an example of this. She doesn't publish that many articles but I know that in her field, what she has done is held in very high

regard. And I think that's one of the reasons that she won out for department chair.
At this point Marcy, an undergraduate, has come in and she joins our discussion.

Marcy: I think this is very interesting. I've wondered before about any differences there may be between male and female scientists and I think it seems to me that the male teachers I've had look at science more traditionally and don't seem to be as progressive as the females. The males have been like "this is how everyone does it, this is how it's always been done and it's how we're going to continue to do it."

S: You think so?

M: Yeah, I guess I'd say that.

S: It might be over-generalizing but it seems to me that men are more linear in their thinking about their approaches to problems and women tend to use more of a combination of approaches. Men will tend to be very goal driven and use one approach, like just cloning or just microscopy, whereas women will consider the context of the wider project and combine a greater number of approaches. So I guess our grant proposal is a good example of that. Bringing a real variety of backgrounds and techniques to a question and trying to think holistically about it.

Me: Yeah, I really see your proposal as an example of what some of the feminist writers would call feminist or successor science.

S: Well…I've always considered myself to be a feminist and a scientist but not really a feminist scientist… but hum, maybe I am…

M: Cool! Can I tell people that I worked for a feminist scientist?

S: (laughing) Well, actually that may not be something that you want to go around advertising. Wait until you already have a job, and then tell them. (interview with Sue; 2/16/1999)

This conversation with Sue and Marcy raised several important issues. First, Sue and Marcy seemed to have similar insights about how women often took more holistic approaches to their practice than their male colleagues. Second, this excerpt showed how contextual and constitutive values were often intertwined and hard to separate out, such that the constitutive often influenced the contextual and vice versa. Finally, the conversation shed light on the topic of how being in the presence of successful women scientists could be a significant influence on how young women scientists-in-training came to view their own place within the culture of science.

Betty Gladstone was the other self-described feminist on the faculty in the biology department, and she also shared an opinion that there were differences between how men and women practiced science, differences that were quite similar to Sue's opinions.

Betty: I think women tend to look at things more comprehensively. We like to synthesize things. We like to... if you look at interdisciplinary areas and newly immerging areas, especially if they are interdisciplinary, you will often find women in those areas. Because we like to put things together to pull things together to create bigger things. (interview with Betty; 3/8/99)

In the few visits I made to Betty's lab, I saw hints of some ways in which her personal research interests and practices were aligned with her belief about women's propensities towards synthesizing and bringing together various perspectives. Betty's research was on the study of parasites, and for the past few years her lab had been studying parasitic worms and their effects on the host organisms.

Betty: I began this work a long time ago pretty much just looking at the evolution of the parasites, but over time I came to realize that you can't really understand the parasite without understanding a lot about the host as well. So now we've gotten very interested in the behaviors of the hosts and how these behaviors might enhance the transmission of the parasite.

Me: That sounds like an example of what we've talked about before in terms of women practicing science in ways that are more holistic. Is that fair to say?

B: Sure, I've thought about that. I certainly wouldn't want to claim that there aren't any male colleagues of mine who are looking at similar issues, but in my own evolution as a biologist, it's certainly fair to say that I've grown broader and broader in my interests and in the connections that I try to make, and that this is a direction that I have seen more in my female colleagues than in my male colleagues. So for example, now we're starting to look at behavioral fever and the role that this plays in alterations of parasitised host behavior, and so that's going to take us in some completely new directions, and we're going to need to bring in some new people with some new expertise. (field note set # 18; 3/30/99)

This last point about needing to attract people with different areas of expertise in order to successfully practice a more interdisciplinary style of science was a pattern that I saw play out repeatedly in Sue's lab. In addition to the diverse team that Sue brought

together for the grant proposal, I witnessed another clear example of this in a personnel change that took place in Sue's lab. When I began the study, Sue had one post-doc, Martin, in her lab. His training was in molecular botany, with a similar background to Sue. When Martin left to take another job, Sue searched for a new post-doc. She interviewed a number of people and decided on a woman from the Midwest named Arlene Bush. Arlene had a very different background; she came from an applied horticulture program and had a fairly weak theoretical understanding of molecular biology but good applied skills working with plants. Arlene came to visit the lab for a week and gave a talk on her dissertation research during the weekly lab meeting.

Arlene: So I'm going to talk about my research on heat stress on pepper plants. Since I'm in horticulture, my study is different than what you're used to seeing in molecular biology. There's no gels or proteins but I do have some pictures of pollen, at least a few, so this won't be completely alien. *Arlene's basic finding is that if the temperature is too high during the flowering stage in pepper plants, fewer flowers will survive to produce fruits. While the fruits that are produced will grow large because there are fewer fruits per plant, the overall fruit mass is less than when temperatures are more moderate which results in a greater number of smaller fruits.*

A: This is a problem in Israel and Greece and other places where they grow a lot of peppers in glass houses and they get high temperatures so people in these countries have shown interest in this research.

V: So this is a real agricultural problem?

A: Right. In this country it's not seen as a big problem because this effect seems to pinch the flowers and prevents too many flowers from germinating so we get fewer but bigger peppers, which is ok here, because US consumers want big fruits. But in a lot of other countries, they want the largest overall fruit mass possible, so it is a problem. So if I were giving this talk to growers I would tell them that there are two critical periods that they have to deal with if they want to control for heat shock… (field note set #18; 3/30/1999)

Arlene's talk was the most practical of all the talks given in the lab and even though it was still looking at the cellular level, the focus was directly on a "real agricultural problem." Everyone in the meeting was struck by the differences between

research in horticulture, which focused on applied problems and research in molecular biology, which generally seemed to be several steps removed from direct applications. While Sue's research interests were definitely theoretical and focused on the molecular level, she valued building a research team with a wide range of skills and experiences, so much so that she had chosen someone with this background to be the only post-doc in her lab. As Sue put it, she saw this kind of collaboration as "having the potential for helping to bridge issues of molecular and organismal biology" (field note set # 18; 3/30/99).

The above examples point to ways in which the increase in women's representation in the biology department at GPU was influencing both the contextual and constitutive values that underlie how biology was practiced in this setting. A case can be made that an increase in women's representation did, in fact, lead to changes in how biology was being practiced at GPU. In taking a practice theory perspective, however, I was also interested in examining ways in which this increased representation did not make a difference in how biology was being practiced. Examples of this kind were in evidence as well, and these are the subject of the following section.

Ways Increased Women's Representation Did Not Alter the Practice of Biology

While the number of examples of shifts in practice seemingly linked to the actions of women in the department steadily grew over the course of my study, so too did counter-evidence pointing to areas where increased women's presence did not seem to lead to a change in the practice of biology research or teaching. One pattern that emerged was that women's success in facilitating change seemed to be related to the individual's place within the status hierarchy of the department.

As discussed elsewhere (Buxton, 2000), the structure of the social spaces of the research labs was strongly hierarchical. While lab members at all levels of experience were expected to be able to work independently on their assigned tasks, the nature of those tasks was generally determined in a strict trickle-down fashion. The professor in charge of the lab, sometimes in conjunction with more senior research associates, set the course of the work that was to be done. Specific problems and questions were then assigned to post-docs and graduate students who in turn, passed on certain tasks to research assistants and undergraduate lab workers. This agenda, and the corresponding tasks that lab members were responsible for, were most often disseminated via weekly lab meetings, where progress was reported and problems were discussed. While these lab meetings had some qualities of open discussion of ideas, in practice, the principal investigator (PI) was very much in charge of designing the big picture for the work to be done. Thus, even in lab spaces where women were well represented, if the lab's PI did not advocate alternative approaches, the kinds of changes outlined in the previous section would be unlikely. The following excerpt illustrates an example of this.

While I was talking with Audrey, Dolores came in. I knew her as the TA for Mickey Frost's course on heredity. She began to complain to Audrey about her work in Mickey Frost's lab.

D: He said no.
A: Who said no about what?
D: Professor Frost said no to me and Bonnie's idea.
A: About wanting to add the genetic counseling piece to the grant proposal?
D: Yeah, we brought it up in the lab meeting when he asked if anyone had any feedback on the proposal idea, but he said he thought [the funding agency] would think it was too scattered and not focused enough. That it would look like we were trying to do too many different things. Bonnie tried to argue that the RFP said they were looking for innovative proposals, but he said we shouldn't take that too seriously, and that for them, innovative meant doing something other than working with fruit flies. He said that maybe at some point down the road we could consider

it, but for now it was in the lab's best interest to just keep building on what he's been doing.

A: That's too bad!

D: Yeah, I thought bringing in an applied component was a good idea. Besides it would have been the perfect way for me to get the kind of experience with genetic counseling that I want.

A: That's why you need to finish your degree and start your own lab. Then you'll get to call the shots.

D: Yeah, maybe one day! (field note set #21; 4/17/99)

This example shows how one's place in the departmental power structure played a significant role in one's ability both to change the direction of science practice and to influence the constitutive values that underlie that practice. Mickey seemed to want to keep his work focused and build on what he was already doing rather than expand the scope of his project. This example also seemed to support Sue and Betty's claims that in their experience male scientists were more likely to walk a single path, while females looked for ways to bring in broader and varied perspectives. Also evident is the role that funding agencies (or the perception of funding agencies) play in channeling research agendas in a given community of practice. This is an area that has been written about in the feminist science studies. As Longino (1990) stated,

> The dependence of most current science on corporate and/or governmental funding makes the conduct of science highly vulnerable to its funding sources. The questions to which the methods of scientific inquiry will be applied are at least partly a function of the values of its supporting context. That the questions also bear a logical relationship to prior research does not rule out their social determination. (pp. 5-6)

In the case in question, Mickey's assessment of the desires of the funding agency appeared to be a major factor in his decision not to include a more applied aspect to his proposal, an aspect proposed by two women graduate students in his lab.

This example illustrated one way in which increased women's representation did not alter the practice of biology at GPU; when those women lacked decision-making

power. A second reason related back to the ideas of individual agency, conformity and resistance. Not all women in the department felt that there were differences in science practice that could be linked to gender. Several women claimed, in effect, that science is universal, and that any differences in approach were more likely to be a result of one's training and disciplinary background than of gender difference. One of the younger women faculty members, Lindsey Smith, was particularly adamant that gender was irrelevant to the practice of science.

Me: So do you feel that there are ways that being a woman influences how you practice science?
Lindsey: Definitely not. I don't think that being a woman has anything to do with my approach to science.
Me: No? Well, what factors would you say influence your approach to science?
L: How you practice science is all about your training. Who have you worked with and how have they trained you?
Me: So does this mean that people just keep working on the things that their major professors were working on?
L: Well, to start with, mostly yes. But then you add your own twist, and over time maybe you move away from that original work.
Me: And what influences where the idea for that twist comes from?
L: Sometimes it's just an idea you get...like a flash of insight, or other times it comes from a synergy with the people you are working with.
Me: And that's not related to the researcher's gender?
L: I don't see how it would be. Disciplinary training and then maybe individual personality traits, that's what's going to determine what you do.
Me: And women who believe that their gender does make a difference in the way they do science?
L: Well, they're obviously entitled to their own opinions about that, but I guess I'd be pretty skeptical of those claims myself. (field note set # 17; 3/18/99)

While some women in the department, such as Sue and Betty, engaged in actions that can be seen as resistance to the norms of science practice as they were traditionally enacted at GPU, Lindsey provided an example of a woman who chose to conform to the traditional beliefs about science practice. Lindsey's perspective points to a significant question that is rarely raised in the feminist science studies. Feminist critiques of science

have claimed that changes in the practitioners will eventually lead to changes in practice. But will this be the case if diverse practitioners do not believe that their diversity is relevant to their practice? In other words, might a woman scientist hold the belief that her gender was irrelevant to her practice, yet still act in ways that would help shift the constitutive and contextual values of science in the direction outlined in the previous section? Similarly, would the presence of men scientists who were aware of and sympathetic to the arguments of the feminist science studies lead to changes in the constitutive and contextual values of science?

In the context of this study, I found that I was unable to answer these questions. I did not study Lindsey's research in detail, however, such a study of the work of women scientists who claim that gender does not influence their practice might prove valuable in the future. I was also unable to locate a man scientist in the department who subscribed to the gender difference argument, a fact that in and of itself may lend some credence to the feminist claims.

While women shared a wide variety of responses to the topic of how gender influenced the constitutive and contextual values of science practice, men were unanimous in their responses. No male with whom I talked was willing to state that they felt there were gender differences in how individuals went about their work in biology. Differences in disciplinary training and questions of individual personality were usually said to be the determining factors in why different people chose to pursue different research questions in different ways. Joe, a post-doc, summarized this perspective when he told me,

Joe: Science is supposed to be value neutral. Who you are shouldn't matter, it's just your ideas that count. That's what makes science fair for everyone.

There isn't supposed to be any discrimination because of who you are. Other scientists consider the merits of your ideas.

Me: And where do those ideas come from?

Joe: Well, mostly from your training, but also from your self. From your individual curiosity.

Me: And none of this is related to one's gender?

Joe: No, I wouldn't say so. Men and women are both curious.

Me: Sure, but are we curious in the same ways? Are we interested in the same kinds of questions?

Joe: Everyone's curious in somewhat different ways, and this leads to different questions, but that's an individual difference, not a group one. (field note set #7; 2/4/99)

Thus, while there was some evidence in this setting that the presence of women at all levels was leading to some changes in the practice of biology, the occurrence and long-term continuance of such changes in practice was not a forgone conclusion. Other factors, such as one's place in the status hierarchy and the role of funding agencies in determining what research was pursued, need to be considered as well. Additionally, the only clear evidence of contextual and constitutive changes I found came from the work of women scientists with some explicitly feminist perspectives, leaving me to question whether women who do not believe that their gender influences their science are still likely to cause shifts in science practice. The question of women's representation changing science practice is one half of the issue I set out to explore. The question that changing practice might lead to an increase in women's representation in science is the other side of the coin.

Questions of Women's Representation

As more women joined the department, their influence continued to grow. Thus, Sue, who was almost not hired, became one of the most vocal advocates for making sure that women were equitably represented in applicant pools, not only in the biology

department, but also across the college of natural sciences at GPU. As she explained to me, the issue of women's representation in biology was one that she had been sensitized to during her days in graduate school.

> First, I think having role models is really important for women in science. My undergraduate experience in science was working with one black man and two women and I think that really helped me feel like I belonged. That really changed when I got to grad school and I was basically with all white men. That was hard, and it almost drove me out of the program. Then at Stanford during my post-doc it was more diverse again, at least in biology. But not in biochem. Biochem was totally white male dominated. But my advisor was a feminist and she really pushed us to go into academic jobs. She wanted to see more women in academic jobs and she really encouraged us to go for those and she fought for us to get those jobs. And so a lot of us from that lab went into academics. I guess a lot of women from my generation are feminists. We're unashamed to compete with men for these jobs and to stick up for women's representation. So every year now I end up on committees that are planning meetings and symposiums and I'm on grant-giving panels and I always insist that we must have at least one woman presenter or one woman applicant. I'm aware that there are plenty of people still in science who think less of women and I try to make sure that there is at least some representation in whatever we do around here. The generation ahead of me had this attitude that you had to be tough in order to get ahead in science, and it was assumed that women weren't tough. But now there's a group of us that have made it into positions with some power, and we watch out for each other. (interview with Sue; 2/16/1999)

Betty made a similar point when she stated,

> At the least, [the increased women's representation] adds a different dimension to how we do business as a faculty, how we problem solve, all that kind of stuff. Because a department is more than just a bunch of scientists doing work. We also have to actually get things done as a group, curriculum changes, committee work.... And I think women have something to contribute in those arenas. I've started to despise our [departmental] faculty meetings less in the last few years. (field note set #15; 3/9/99)

While the above examples focus on the results of contextual changes on faculty interactions in the department, examples of the effects of these changes at the undergraduate level also exist. For example, Phyllis felt that it was important to build a

sense of community among undergraduate majors, and she was interested in how to make these students feel that they were part of the biology program. She made sure that some students got opportunities to work in the social spaces of the research labs and other students worked with the TA^2 program (a program in which advanced undergraduates helped teach the introductory lab courses). Sandy and Beth, the lab course coordinators, provided access to opportunities for any interested major to enter a set of social spaces that provided a different look at what it meant to be a biologist, a perspective that was very much grounded in a sense of collaboration and community. These and other social spaces available to undergraduates in the department are described in greater detail elsewhere (Buxton, 2000). For the purpose of this paper, the important point is that female students were especially prone to take advantage of the TA^2 opportunity (by about a 3:1 margin), and some talked explicitly about the sense of belonging they felt as a result of their participation.

Me: So what was the most valuable thing you got out of participating in TA^2?
S: I'd say definitely it was being part of the group. I mean [GPU] is a big place and I really felt lost a lot of the time my freshman and sophomore years. I mean I wasn't in a sorority or anything and so I didn't really belong to any groups. But then when I started doing TA^2, right away they made me feel like I belonged. So that's why I did it for four semesters. They were people I liked to be with and a place where I could go to hang out. (field note set #10; 2/16/99)

This student's experiences recall Kleinman's (1998) work, in which she discussed how prototypical images of science and scientists often serve as a filter, limiting women's willingness to adopt a scientific identity. Opportunities such as the TA^2 program, however, provided a safe haven for women to develop identities as scientists in a supportive environment.

Reconsidering "Authentic" Science Experiences

Thus far, I have painted a picture of what "authentic" science practice looked like in the GPU biology department. In the final section, I will connect this picture to the question of whether presenting women biology students with "authentic" science experiences was likely to increase their interest in pursuing careers in research science. Female undergraduates with research experience at GPU gave various reasons for choosing a particular career path. These choices were often made in light of their like or dislike of various aspects of their research experience and how these experiences shaped their ideas about being a scientist. Many of these students came to view science and scientists in ways that were similar to the views of the faculty members with whom they worked. In other words, these students were getting an "authentic" picture of research science, however, this did not necessarily translate into a desire to continue into careers in research science themselves.

The students who had opportunities to work in the high status social spaces of the research labs were granted access to the cultural capital needed to go farther in the field, and for some of these students, the role of "authentic" science experiences seemed to work to motivate them to continue on in science. This aspect of my findings seemed to support the arguments made by Nespor (1994), Traweek (1989) and others that university science programs are set up in order to enroll some students (those deemed to have the most potential) more tightly into the network of practice for that discipline, and prepare them to enter that career trajectory, while other students (those who are not deemed to be standouts) receive a fundamentally different training in the discipline.

As the comments of a number of students at GPU indicated, however, not everyone who had access to this potentially valuable cultural capital chose to accept and use it. Women, in particular, were more likely to choose voluntarily alternate paths that led to positions at GPU, and eventually to jobs beyond the university that had lower status and less prestige. In these lower status positions, many women felt better able to align their work in science with their values, beliefs or desires. This finding complicates the arguments made by Nespor (1994) and Traweek (1989), but does resonate with Eisenhart and Finkel's (1998) study of women practicing science from the margins. The reasons women opted for lower status positions were varied, but several patterns emerged through the course of my study.

This voluntary marginalization of women could be clearly seen by comparing the predominance of females in the TA^2 program with the male domination of the undergraduate RA program. While there were some male TA^2s and a number of female undergraduates working in research labs, the proportions were skewed. Roughly 75% of TA^2s were female and about two-thirds of undergraduates working in research labs at GPU were male. Additionally, the females who were working in labs tended to be clustered primarily in the labs of a few female faculty members. While there was nothing inherently wrong with men and women students in the department tending to choose different opportunities to receive additional science experiences, these numbers became problematic when considered from the perspective of the relative status of these positions (discussed in detail in Buxton, 2000).

Because of the types of work done and the limited number of positions, opportunities to work in research labs were considered the highest status opportunities for

undergraduates in the biology department. The TA^2 program, which was available to nearly any interested student and which did not entail the production of new research, was not seen within the department as a prestigious opportunity. Despite the lower status of the TA^2 program, however, many women had very positive experiences participating, and made decisions about their future in science at least in part as a result of those experiences. As Leanne, a TA^2 described it,

> Yeah, I've really enjoyed the experience. It's interesting to come back to the freshman level stuff. I remember when I was a freshman everything felt really hard and confusing and now as a senior it all seems really basic. So it's a challenge to try to figure out what the appropriate way is to present the material in a way that makes sense to the freshmen. Like earlier in the semester I got to teach about meiosis and mitosis. I didn't have to teach that stuff but I wanted to see what being up in front teaching the whole class was like. So Tina [a graduate student] let me do it for two weeks. I learned that teaching is really hard work! But I really enjoyed it too. It's got me thinking seriously about going into science teaching. I started as a bio major because I wanted to be a field biologist, but I think I've changed my mind. I find the challenge of teaching biology very enjoyable. When I signed up for TA^2 I thought I'd just do it this semester, but the chance to work closely with Tina has been great and so I think I'm going to do it again. (field note set #20; 4/8/1999)

Thus, Leanne's experiences in a low status position were so positive that they led her to consider a change in career path, one leading her away from science practice and into science teaching. I found many similar examples of women biology majors finding positions around the department where they felt comfortable, but which did not grant them access to the high status "authentic" science settings of the research labs. On the flip side of this, while some women were quite happy with their research opportunities, I met a number of other women in "authentic" lab settings who found various aspects of working in a lab not to be enjoyable and who left those positions to pursue other interests. For example, Julie worked in Sue's lab for several semesters, but was planning to leave

because she was unable to get her own research project and was tired of the time commitment and the endless menial tasks.

> Actually I've been here longer than any of the other undergrads, and I'm kind of sick of filling tip boxes and making broth. But I guess I don't spend as much time in the lab as some of them do because I'm really busy being a resident assistant in the dorms. And I haven't even gotten my own research project even though Clark and Quinn both have and they came after me. But hey, they were both really enthusiastic and they bugged Sue and asked to learn stuff and so Matt taught them some basic techniques and then Sue gave them projects. I guess I just haven't bugged her enough. So, I guess it's my own fault and I shouldn't complain about it. But I think I'm going to stop after this semester and focus my attention on other things. (field note set #14; 3/4/1999)

In contrast, male students who were given opportunities to work in research labs in the biology department seemed more likely to feel comfortable with, and thus choose the paths that led to higher status and which allowed them to become more tightly enrolled in the network of power of biology practice. The following excerpt from a conversation with Clark, another undergraduate working in Sue's lab, both reflects the attitude it took to be successful working in the research labs and points to several reasons why some women may have been less happy in these positions.

> *Clark begins to explain the project that he is working on to me. It involves looking at proteins in the cells walls of the pollen tubes in sorghum plants. He describes the proteins as being like a stick with a ball on the end with the stick embedded in the cell wall.*
>
> Clark: It's been driving me absolutely crazy! I've been stuck on the same little piece of the problem for about a month now and I just can get it. But I love this stuff. It makes me crazy but I love it! The challenge of figuring out something that no one else has ever figured out before. I'm starting to feel like a hermit. I've been working late nights here in the lab, I've been blowing off some classes, I haven't been spending time with my friends, but I don't care. I'm going to figure this out or I'm going to die trying! (field note set #1; 1/7/1999)

Holland and Eisenhart (1990) have shown that there are strong social forces within undergraduate peer groups that make it extremely difficult for college women to

take on the kind of single-minded devotion that Clark indicated was necessary for him to succeed in research. This is not to say that women cannot find places for themselves within such a culture. In fact, I have tried to show a number of places in this setting where women did just that. This argument does imply, however, that as long as the framework of this culture remains more or less intact, women will be more likely than their male counterparts to choose paths that lead away for the research lab. Instead, women are likely to seek out spaces, such as the life science clubs and the TA^2 program, that foster community and permit a more balanced lifestyle (Buxton, 2000). These spaces, in turn, drop in status and prestige as they become less populated by the prototypically male norms of science practice. This argument also implies that women who do seek out and succeed in obtaining high status and high power positions, are likely to pay a higher cost in terms of reconciling their position with their own personal values, beliefs, language, and lifestyle. In the GPU biology department, I found this to be true at the level of the faculty as well.

For example, by accepting the job as department chair, Phyllis opened herself up to a considerable amount of criticism and critique. While some faculty (mostly women) though very highly of her, other faculty, both men and women, described her as "pushy," "opinionated," "demanding," or "strong-willed," attributes that were always implied to be negative qualities. Unless women occupy these positions of status and power, however, there is little opportunity to resist elements of the culture of science as it is practiced, and through that resistance slowly begin to cause changes within that system of practice. Women who opt for lower status positions within the culture of science, or those who opt to leave this community of practice altogether have less (or no) opportunity to resist in

ways that are likely to lead to meaningful changes. Thus, the changes that members of the GPU biology community with less power tried to enact appeared to have no lasting effect, while some of the changes advocated by those individuals in positions of greater power were meeting with some success.

This argument, that an increased representation of women in the practice of science may cause changes in how that science is practiced, but only in so far as those women are in positions to make decisions that can cause changes, is not completely new, and reflects the findings of Eisenhart & Finkel (1998), Harding (1991), and others. This study has added additional empirical evidence collected in a site where mainstream science was being practiced and where women seemed to be having some success. By spending the better part of a year acting as a participant observer in a setting where scientific knowledge was actively being constructed and where women were significant players in this knowledge construction, I became convinced of two things. First, there are fundamental ways in which the practice of science is constructed that make it more difficult for women to use their strengths effectively in that practice and to be recognized and acknowledged when they are successful at doing so.

Second, in a setting where women have, over time, made significant inroads in terms of representation in science practice, as was the case at GPU, these women can cause gradual change in the practice of science within that setting. This change must be slow because any given setting of science practice is connected to all the other settings within the same discipline across time and space, and radical changes would push that setting out of alignment with the rest of the discipline. However, gradual change is possible when the right conditions are in place. Those conditions include leadership that

is willing not only to allow change but also to advocate for it, and individuals who are willing to take risks (e.g. to their status, prestige, and comfort) in order to bring about that change.

In other words, under the right circumstances, changing representation can lead to changes in science practice and changes in practice can lead to changes of representation within science. These changes are not a foregone conclusion, however, and depend upon issues of individual conformity and resistance. For example, opportunities to engage in the practices of "authentic" science may be beneficial to some students and lead them to continue along paths that will enroll them more tightly in the community of science practice but may convince other students that science practice is not for them.

The complexity of this situation makes it difficult to offer clear recommendations to individuals or institutions looking to enact programs to increase the recruitment and retention of women in the natural sciences. Opportunities that help women to feel connected to the practice of science, a willingness to listen to women's voices and experiences with science, opportunities for women to both make choices and to consider the impact of those choices on their career trajectories, the availability of women role models, and a consideration of how changing practitioners can lead to changing science practice, can all have a positive impact on the willingness of particular individual women to continue on and excel in science research careers.

Implementation of any of the above strategies, however, by no means assures that a science department will be successful at recruiting and retaining women. What is clear is that traditional science practices are more likely to discourage women than men at all levels, from undergraduate students to faculty. The belief that presenting "authentic"

science learning opportunities to students will be sufficient to encourage these students to continue to pursue science careers seems to be flawed. Only when the "authentic" practices themselves have changed are more women students likely to see research practice as an appealing path to travel.

References

Alic, M. (1986). Hypatia's heritage: A history of women in science from antiquity through the Nineteenth Century. Boston, MA: Beacon Press.

Barab, S. A., & Hay, K. E. (2000). Doing science at the elbows of experts: Issues related to the science apprenticeship camp. Journal of Research in Science Teaching, 38(1), 70-102.

Biology and Gender Study Group. (1989). The importance of feminist critique for contemporary cell biology. In N. Tuana (Ed.), Feminism and science (pp. 172-187). Bloomington, IN: Indiana University Press.

Buxton, C. (1999). Of mice and men: How to succeed in molecular biology. A paper presented at the 1999 meeting of the National Association of Research on Science Teaching, Boston, MA.

Buxton, C. A. (2000, April 28-30, 2000). Gender equity in theory and practice: Exploring localized meanings of science and scientist. A paper presented at the annual meeting of the National Association of Research on Science Teaching, New Orleans, Louisiana.

Eisenhart, M., & Finkel, E. (1998). Women's science: Learning and succeeding from the margins. Chicago, IL: University of Chicago Press.

Erickson, F. (1986). Qualitative methods in research in teaching. In M. Wittrock (Ed.), The Handbook of Research on Teaching (3rd ed., pp. 119-161). New York, NY: Macmillan.

Gornick, V. (1983). Women in Science: Portraits from a world in transition. New York, NY: Simon & Schuster.

Graue, M. E., & Walsh, D. J. (1998). Studying children in context: Theories, methods and ethics. Thousand Oaks, NJ: Sage Publications.

Gross, P., & Levitt, N. (1994). Higher superstition: The academic left and its quarrels with science. Baltimore, MD: Johns Hopkins Press.

Haraway, D. (1989). Primate visions. New York, NY: Routledge.

Harding, S. (1989). Can there be a feminist method? In N. Tuana (Ed.), Feminism and science (pp. 17-32). Bloomington, IN: Indiana University Press.

Harding, S. (1991). Whose science? Whose knowledge? Thinking from women's lives. Ithaca, NY: Cornell University Press.

Hartsock, N. I. E., (pp. 157-180). Indiana University Press. (1983). The feminist standpoint: Developing the ground for a specifically feminist historical materialism. In S. Harding (Ed.), Feminism and methodology . Bloomington, IN: Indiana University Press.

Hrdy, S. B. (1991). Empathy, polyandry, and the myth of the coy female. In R. Bleier (Ed.), Feminist approaches to science (pp. 119-146). New York, NY: Teachers College Press.

Keller, E. F. (1977). The anomaly of a woman in physics. In S. Ruddick & P. Daniels (Eds.), Working it out: Twenty-three women writers, artists, scientists, and scholars talk about their lives and work (pp. 78-91). New York, NY: Pantheon Books.

Keller, E. F. (1985). Reflections on gender and science: Yale University Press.

Keller, E. F. (1992). Secrets of life, secrets of death: Essays on language, gender, and science. New York, NY: Routledge.

Kelly, G., Carlsen, W., & Cunningham, C. (1993). Science education in sociocultural context: Perspectives from the sociology of science. Science Education, 77(2), 207-220.

Kleinman, S. S. (1998). Overview of feminist perspectives on the ideology of science. Journal of Research in Science Teaching, 35(8), 837-844.

Kohlstedt, S. G., & Longino, H. (1997). The women, gender and science question: What do research on women in science and research on gender and science have to do with each other? In S. G. Kohlstedt & H. Longino (Eds.), Women, gender and science: New directions (Vol. 12, pp. 3-15). Chicago, IL: University of Chicago Press.

Laqueur, T. (1990). Making sex: Body and gender from the Greeks to Freud. Cambridge, MA: Harvard University Press.

Levinson, B. A. (1996). Social difference and schooled identity at a Mexican secundaria. In B. A. Levinson, D. E. Foley, & D. Holland (Eds.), The cultural production of the educated person: Critical ethnographies of schooling and local practice (pp. 211-238). Albany, NY: State University of New York Press.

Levinson, B. A., & Holland, D. (1996). The cultural production of the educated person: An introduction. In B. A. Levinson, D. E. Foley, & D. Holland (Eds.), The cultural production of the educated person: Critical ethnographies of schooling and local practice (pp. 1-54). Albany, NY: State University of New York Press.

Longino, H. (1989). Can there be a feminist science? In N. Tuana (Ed.), Feminism and science (pp. 45-57). Bloomington, IN: Indiana University Press.

Longino, H. (1990). Science as social knowledge: Values and objectivity in scientific inquiry. Princeton, NJ: Princeton University Press.

Luykx, A. (1996). From Indios to profesionales: Stereotypes and student resistance in Bolivian teacher training. In B. A. Levinson, D. E. Foley, & D. Holland (Eds.), The cultural production of the educated person: Critical ethnographies of schooling and local practice (pp. 239-272). Albany, NY: State University of New York Press.

Martin, E. (1992). The woman in the body: A cultural analysis of reproduction. Boston, MA: Beacon Press.

National Science Board. (1999). Preparing our children: Math and science education in the national interest. (Vol. NSB99-31). Arlington, VA: National Science Foundation.

National Science Board. (2000). Science & Engineering Indicators - 2000 (NSB-00-1). Arlington, VA: National Science Foundation.

National Science Foundation. (1996). Shaping the future: New expectations for undergraduate education in science, mathematics, engineering and technology . Washington, D.C.

Nelson, L. (1990). From Quine to a feminist empiricism. Philadelphia, PA: Temple University Press.

Nespor, J. (1994). Knowledge in motion: Space, time, and curriculum in undergraduate physics and management. London, England: Falmer Press.

Phillips, P. (1990). The scientific lady: A social history of women's scientific interests 1520-1918. New York: St. Martins Press.

Rose, H. (1983). Hand, brain, and heart: A feminist epistemology for the natural sciences. Signs, 9(1).

Rossiter, M. (1995). Women scientists in America before Affirmative Action 1940-1972. Baltimore, MD: Johns Hopkins Press.

Rossiter, M. (1997). Which science? Which women? In S. G. Kohlstedt & H. Longino (Eds.), Women, gender and science: New directions (pp. 169-185). Chicago, IL: University of Chicago Press.

Rutherford, F. J., & Ahlgren, A. (1990). Science for all Americans. New York: Oxford University Press.

Sands, A. (1993). Never meant to survive: A Black woman's journey--An interview with Evelynn Hammonds. In S. Harding (Ed.), The racial economy of science: Toward a democratic future (pp. 239-248). Bloomington, IN: Indiana University Press.

Schiebinger, L. (1989). The mind has no sex? Women in the origins of modern science. Cambridge, MA: Harvard University Press.

Schiebinger, L. (1997). Creating sustainable science. In S. G. Kohlstedt & H. Longino (Eds.), Women, gender and science: New directions (pp. 201-216). Chicago, IL: University of Chicago Press.

Seymour, E., & Hewitt, N. M. (1997). Talking about leaving: Why undergraduates leave the sciences. Boulder, CO: Westview Press.

Spradley, J. (1979). The ethnographic interview. San Francisco, CA: Holt, Rinehart & Winston.

Tonso, K. (1999). Engineering gender -- Gender Engineering: A cultural model of belonging. Journal of Women and Minorities in Science and Engineering, 5(4), 365-405.

Traweek, S. (1989). Beamtimes and lifetimes: The world of high energy physicists. Cambridge, MA: Harvard University Press.

Van Maanen, J. (1988). Tales from the field: On writing ethnography. Chicago, IL: University of Chicago Press.

Willis, P. (1977). Learning to labor: How working class kids get working class jobs. New York: Columbia University Press.

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