Frequently Asked Questions about Feminist Science Studies

Question One: *What is meant by "feminism," and what does it have to do with science?*

Feminism has never been monolithic. In fact, it is quite common at women's studies conferences to see references to feminism that acknowledge it as a wide array of ideological, scholarly, and political viewpoints. Nonetheless, feminists share a common understanding that women have historically been devalued and denied full equality. Feminism therefore provokes questions about undeserved power differentials in society.

Feminism has influenced the production of scholarship throughout the academy, including the sciences, especially since the reemergence of the women's movement in the late sixties and the establishment of women's studies as an academic field of inquiry. Academic feminism has been rooted primarily in the humanities and social sciences, where it has sought to examine the absence of or distortions about women, document the contributions of women in many fields, and understand the mechanisms that keep subordination and marginalization in place. Such questions have deep relevance to the sciences and have been part of the emerging feminist science studies scholarship.

In addition to theorizing about women and gender, feminism has led to a tougher scrutiny of the term "universal." In social sciences, for instance, feminism has elucidated how broad theories that claim "universality" actually are more often partial, based on a white, male norm rather than a more inclusive representation of humanity. What might appear "universal" is often based on only a small portion of a population. Lawrence Kohlberg's theory of moral development, for instance, which had been constructed by observing an all male sample, has been called into question as a universal model by Carol Gilligan, who constructed a complementary model by listening to women. Gilligan's work has subsequently been questioned by Michelle Fine and others who suggest that Gilligan's model is limited as it refers to class and race. Examining such assumptions has therefore promoted constructive critical thinking in many fields, including the sciences.

Until recently, many in the sciences have been largely unengaged in feminism or feminist scholarship. Similarly, many feminists and many in women's studies have frequently ignored science or even been suspicious or critical of what was perceived as its hostility to women. Until the 1990s, very few women's studies programs included science in their curriculum. This has begun to change. Because there are now more women in science, more women teaching science, more feminist scholarship about science, and more and more of it produced by scientists, feminism and the sciences have recently embarked on an exciting period of cross-fertilization.

An example of one of the benefits of this exchange is the rich investigation into the meaning and nature of biological sex differences (female or male) and the socially constructed definitions of gender (femininity and masculinity) that vary widely across time, place, income, and race. For example, in "The Egg and the Sperm: How Science Has Constructed a Romance Based on Stereotypical Male-Female Roles" (1991), Emily Martin shows how scientists have superimposed cultural sex stereotypes inappropriately onto the process of fertilization, resulting in inaccurate descriptions of cell and molecular interactions, faulty understandings of the physiology of fertilization, and skewed research priorities. Feminist scholarship also examines ways in which ideas about sex and gender have influenced our real and imagined worlds, which Donna Haraway explores in illuminating ways in *Primate Vision: Gender, Race, and Nature in the World of Modern Sciences* (1989). In this work, Haraway investigates how scientific findings in primatology have been deeply constrained and even flawed by gendered and racialized notions. She argues, for example, that before the 1970s primatologists unwittingly imposed their gendered template on their scientific work, leading them to study only the behavior of male primates or the adult female only in a mother-child relationship. As a result, they developed an inaccurate understanding of primate behavior, lacking attention to the role of female primates, including the extent of their sexual choice, aggressiveness, or even polyandrous behavior.

In applying feminist analyses to scientific ideas and practices, feminism sees science, like all spheres of intellectual activity, as conditioned by historical circumstances, societal beliefs, and accepted norms. In this analysis, therefore, it is logical that values and concepts associated with maleness and femaleness, bound as they are by time and place, would influence scientific scholarship and practice as they do other spheres of intellectual or social activity. An initial task of feminist science studies scholars has been to identify in what ways notions about gender have, in fact, influenced scientific thought and practice.

Feminist analysis has helped us understand why women have not participated fully in scientific communities and why many still feel unwelcome when they do. It also articulates the reasons why it is advantageous to science that there be a diversity of people and perspectives in the scientific community. Finally, feminist analysis helps to improve more traditional accounts of science and may contribute to substantive changes in both the culture and content of scientific practice and knowledge. By correcting distortions, feminist scholarship can lead to more accurate and less culturally limited representations of the natural world. This improved science may attract more women to the field as well as benefit those influenced by its findings.

Question Two: *What is feminist science studies, and how did it originate?*

Feminist scholars in the sciences and in the history and philosophy of science have been analyzing and examining scientific theories and practices for the past fifteen to twenty years. Beginning with ground breaking works by feminist scientists like Evelyn Fox Keller, Anne Fausto-Sterling, Ruth Hubbard, and Marion Lowe, and feminist philosophers like Sandra Harding, feminist science studies is now a thriving field of scholarly activity with increasing numbers of practitioners in the U.S. and around the world. While not necessarily called "feminist science studies" in earlier periods, many of the ideas in this field, in fact, extend back into the last century of the women's movement.

Feminist science studies today and in earlier periods has brought to the study of science an awareness of the costs of excluding women and other marginalized groups from full participation in science. Part of the loss is to those excluded individuals who, because of their sex, racial-ethnic background, or class, have been deprived of the pleasures and challenges, the rewards and power, of studying and "doing" science. But society as a whole has lost out on the talents and insights that they could have brought to science and technology.

As astronomer Maria Mitchell commented in 1873, "I used to say, 'How much women need exact science,' but since I have known some workers in science who were not always true to the teachings of nature, who have loved self more than science, I have now said, 'How much science needs women.'" Mitchell's comment presages today's feminist science studies. When scientists assume that simply using the scientific method assures that their personal and cultural values are not affecting how they do science and thus what science they develop, they fail to acknowledge that their biases might affect science at all stages of development. As Helen Longino has pointed out in *Science as Social Knowledge* (1990), social and political interests, as well as personal biases, have an impact on the production of scientific knowledge. Social, political or personal interests can affect:

—how scientists set priorities for scientific investigation;
—what questions are posed about a topic;
—what explanatory framework or theory frames a scientific study;
—what methods are used;
—what data are considered valid and invalid;
—how data are interpreted;
—how data in one study are compared to data in other studies;
—what conclusions are drawn from the analysis of scientific data; and
—what recommendations are made for future studies.

That does not mean that feminist science studies argues that African-American women, for example—or Puerto Rican men or white women—necessarily look at scientific problems differently from the white men who have dominated Western science. But which problems or diseases, for example, are chosen for intensive study by a scientific community is likely to be determined by what that community knows about and what it thinks is "important." In the U.S., for example, funding for breast cancer research did not become a Congressional priority until women's health activists organized and lobbied for more funds and for a rethinking of standard scientific approaches to the problem.

Scholars in feminist science studies have pointed not only to neglected areas of scientific research but also to the uses and abuses of that research. In the same year that Maria Mitchell appealed for the inclusion of women in science, Dr. Edward Clarke published his highly influential book, *Sex in Education, or a Fair Chance for the Girls* (1873). Alarmed about women trying to gain admission to American colleges that did not admit women, or to new schools for women, like Vassar and Bryn Mawr, Clarke claimed that women would ruin their health if they went to college. Worse, they would impair their ability to bear children. The evidence for Clarke's treatise consisted of a smattering of anecdotes about a few young women whose physical or mental health suffered after attending college for a year or two.

Despite the anecdotal and incomplete nature of his evidence, Clarke's book went through multiple editions and was widely cited as scientific evidence that women should not, for their own sakes and for the sake of society, go to college. In response, Dr. Mary Putnam Jacobi, a leading female physician, did survey research of young women attending college and found no significant negative effect on their health. Even in the nineteenth century, then, a form of feminist science studies existed. It emerged from a concern for fairness and equity for women as full participants, recognized and rewarded for their contributions in all sectors of society. A more complete description of this early period of activism by women scientists and physicians can be found in Margaret Rossiter's groundbreaking study, *Women Scientists in America* (1982).

As large numbers of women gained access to colleges and universities in the 1970s, contemporary feminist science studies emerged in a new form. For the past several decades, feminist scholars have amassed convincing evidence that cultural beliefs about gender, race, and class have strongly influenced our current structures of knowledge. This scholarship developed, in fact, at the same time that other fields were being transformed by feminist ideas. Scholars inside and outside of science asked the same questions of the fields of science as their colleagues were asking in other fields like history, psychology, or literature: Where were the women in science, and how was their work valued? What was their history? How might constructing a more accurate history of science, one that takes women seriously, influence our understanding of both the history and the specific content of science? How have traditional understandings of and assumptions about gender influenced the production of scientific knowledge? How do cultural beliefs about gender affect the priorities, methods, and methodologies in the sciences?

Such an approach requires understanding science in relation to forces—political, economic, social—that shape it and the people who dominate the field. Science studies in general seeks to understand science as a human endeavor, and feminist science studies recognizes that categories of masculine and feminine—as well as other major categories of "difference"—carry meanings of differential power and status in society, affecting the sciences as they do other fields.

Feminist science studies scholars address a variety of equity issues. They are concerned not only with women and gender, but also with any group denied access, encouragement, and resources—whether inadvertently or by design. Feminist science studies is also concerned with the historical uses of science to justify inequalities. Its scholars believe that scientists and science shapers need to understand and acknowledge how science was and is involved in discrimination, so that they may break such patterns.

These scholars work to eliminate current biases, teach how values enter into and shape science, and promote ideals of fairness, equity, and justice in the development of and uses of science.

Question Three: *Does feminist science studies suggest a form of relativism where all perspectives are "right"? Doesn't science need to remain objective?*

Probably one of the most common misconceptions about feminist science studies is that it is somehow anti-science or rejects the basic tenets of the scientific method. Scholars in the field of feminist science studies, as well as many other scholarly fields that intersect with the philosophy of science, have convincingly argued that science is not and can never be culturally neutral, and yet feminist science studies scholars have refused to reject all scientific methods or notions of objectivity. Feminist science studies simply argues that scientists do not work in a void; pure objectivity is impossible. Science defined as aperspectival and free of biases is an oversimplified and false representation of science.

Building on the groundbreaking work of Thomas Kuhn, feminist science studies scholars have argued that scientific objectivity doesn't simply rest with individual scientists. Instead, it is the result o f a consensus reached by a community of scientists working within a cultural context. The fact that communities of scientists have traditionally been comprised primarily of white men of privilege has had a profound impact on how scientific practice and understandings of objectivity have developed.

Technologies, the language of science, and research strategies are all human constructs. Scientists do not just discover laws and identify "truths." Practicing scientists construct hypotheses by examining the world, experimenting with using the tools they invent, and interpreting what they find within the context of what they know. Scientists constantly make judgments in the course of their work. They determine whether the results of an experiment or a set of data are valid, consistent with previous results and with prevailing explanatory frameworks, or spurious—the result of identifiable or unidentifiable errors. These judgments are rendered within a set of assumptions that may be influenced by cultural, scientific, and individual beliefs and values.

Does this mean that all scientific knowledge is relative? Certainly not. Feminist science studies suggests that scientific communities are *more* objective when unexamined biases are brought out into the open. Feminist scholars like Sandra Harding, Helen Longino, and many others also celebrate the utility and value of scientific endeavors.

Further, no one is arguing that what scientists have done "does not work." The ability to reproduce experiments and make predictions is highly valued, and scientists should continue to use these valuable methods of inquiry. But to embrace the value of scientific methods and "products" does not mean that one can assume all of science is free of political influences or that a scientist's desires and interests do not influence his or her work.

Scientists are engaged participants in their work. They use reason and intuition much as artists and writers do. Further, embracing the feminist science studies tenet that all knowledge is "situated" in some context should only strengthen the scientific method. In studying the natural world, for instance, any search for context dependency, for how methodological and epistemological concerns may influence how scientists construct theories and define what is knowledge, should deepen how one understands the natural world, not weaken it. Feminist scientists do not see this as a debate between objectivity and relativism. The real goal is to strive for what Sandra Harding has called "strong objectivity"—where all sources of error or bias, cultural as well as technical, are taken into account.

Question Four: *Since it is sometimes critical of existing scientific paradigms and practices, won't feminist science studies discourage women from pursuing science?*

Data suggest that, long before feminist science studies existed, many women were discouraged and dissuaded from science as it was practiced and taught. Feminist science studies scholars have been part of reform efforts to reverse that trend. Rather than discouraging women from science, feminist science studies seeks to draw women to science and to foster scientific literacy. It addresses issues of access and retention of women in scientific fields by providing multiple entry points and perspectives for women and other minority groups who have been traditionally underrepresented in science fields.

Feminist science studies does, however, ask students, faculty, administrators and others — scientists and non-scientists, male and female — to rethink their foundational ideas about science. In its challenge to scientists to examine their assumptions about their work and acknowledge that societal values and beliefs affect their scientific practice, the literature of feminist science studies invites both female and male students to consider what it means to be a scientist.

Several studies indicate that while there have been dramatic gains in the numbers of undergraduate women students in science, mathematics, and engineering, the percentages of women pursuing postgraduate work declines. In 1993, women received 45 percent of all bachelors degrees in science, 36 percent of all masters degrees in science, and only 30 percent of all Ph.D.s in science and engineering fields (NSF 1996). These numbers vary significantly according to the field of science, as well, with the numbers of women in physics far lower than the numbers of women in biological sciences, for example.

In looking at the reasons for uneven or declining numbers, researchers find that female students face a variety of obstacles that keep them from pursuing careers in science fields. These obstacles include low expectations from parents and teachers, lack of self-confidence in their ability to "do" science, and overt and covert sexual harassment and discrimination by male colleagues and/or advisors. In addition, when female students find themselves one of the few women in a science class or department, the isolation can be very difficult. Also, the prospect of a lifestyle as a scientist that requires long hours and often does not make room for the possibility of having a family makes considering a career in science unattractive to many women.

To encourage women to pursue scientific majors and/or careers, the literature of feminist science studies suggests ways of practicing and thinking about science that are more inclusive and welcoming for women — and in the process often result in better science education for all students, male and female alike. Some changes advocated by feminist science studies scholars include the use of more collaborative learning, group work, and experiential education frameworks in science courses; the increasing use of scholarship on the history of science, so that women students can place science in its historical context and see why past scientific practices and ideas have discouraged women from becoming scientists; and attention to increasing the number of female mentors and faculty members in the sciences to help address climate issues for female students.

While it challenges some students' expectations about science, feminist science studies often, in fact, works to attract rather than discourage women from pursuing science careers. Feminist science studies opens up science to new viewpoints and allows women to approach scientific work in multiple ways. This, in turn, encourages women to see the rewards in studying science without requiring them to give up their gender identifications and other interests in order to succeed.

Question Five: *How can I possibly incorporate feminist science studies into my courses when I already have insufficient time to cover everything?*

The question of content coverage has historically been hotly contested in many disciplines. In many ways this is a practical question to ask of science teachers because of an ever more rapidly growing store of scientific knowledge. It is a practical question not in the sense of "How do I do this new work in my classroom and laboratory?" but, rather "How can I use the literature of feminist science studies to help set priorities in my courses?"

Many teachers have responded to the explosion of scholarship by developing frameworks of selection and coalescence of factual material, usually moving to greater generality and to teaching some key concepts. Establishing these key concepts has always involved some level of controversy and negotiation. Those who teach science courses, particularly at the introductory level where one needs to lay the broadest foundation, feel that conceptual clarity is gained at the expense of a dream of "complete coverage."

Feminist science studies provides a thoughtful, practical, and theoretically rigorous framework — an additional set of intellectual tools — for carrying out this process of selection and synthesis. It suggests avenues for the reform of particular courses as well as the reconfiguration of departmental programs. The systematic insights of feminist science studies scholars can provide students with a broadened context for understanding key scientific concepts. This context can promote more effective learning and retention of important content. Teaching science in context can motivate students who might otherwise turn away from science. They are more motivated because they can identify avenues of connection to their own lives and develop a greater appreciation of the more general links between the sciences and their social, political, economic, and ethical contexts. This also teaches students to pose even better questions about the content in science courses.

Question Six: *What specific relevance does feminist science studies have for scholarship and teaching in the physical sciences, engineering, and mathematics?*

Many people question the relevance of feminist scholarship to the so-called "hard sciences." Admittedly, the connections are not always readily apparent for those who teach in disciplines such as math, engineering, and the physical sciences. However, feminist science studies does indeed have implications for both research and teaching practices in these domains. We begin here by examining feminist ideas relevant to mathematics, as its principles are employed by almost everyone who teaches in science and engineering fields.

It is commonly assumed that mathematics is culturally neutral because it deals with abstractions, presumed to be stripped of all cultural context, and therefore not culture-laden in any obvious sense. However, recent scholarship (both in feminist science studies and especially in the new field called ethno-mathematics) supports the view that culture and language influence mathematics itself and that different societies have different versions of mathematics. Feminist scholars have been arguing for at least two decades that "culture is classification." How people categorize things is one of the major differences between one culture and another. And mathematics is certainly, among other things, a system of classification.

In mathematics, problems of interest at particular historical moments have led to a particular set of methods and techniques that constitute a large part of the body of mathematical knowledge. However, these existing methods then determine the kinds of problems and applications pursued in the field. Consider the inherited methodologies that proceed by reducing the complex to the simple. Alternatively, complexity could be valued over simplicity, and we could privilege properties exhibited by whole systems over the study of individual constituents acting independently. This is not to say that feminists necessarily advocate embracing the value of complexity over simplicity; it is rather to point out that operating with different world views may lead to organizing things differently. Another example is the historical privileging of linear and hierarchical relationships in Western mathematics over non-hierarchical and non-linear ones. Consider also the fact that if set theory or differential equations are justified because they "work" for physics, using other disciplines as one's starting point might justify different mathematics, different logics.

As yet another example, consider the dominance of the ideal of a logical proof in Western mathematics. As Bonnie Shulman argues in her article, "What if We Change our Axioms?" (1996), accepting this ideal as a dominant yardstick leaves out things that elude systematic analysis and (re)organization. One observes things readily classified with known names, and overlooks or disregards everything else. Particular frameworks determine what constitutes not only an answer, but even the questions asked. As in the other scientific fields in which feminist science studies has had an impact, in an area like mathematics, feminist science scholars urge paying attention to what has not been studied—what has been left out—as well as to assessing the validity of current theories.

Feminist science studies scholars also suggest that it may be unhelpful in the pursuit of knowledge or social change to cling to a belief that one system or theory will be found to explain everything worth explaining. The world, especially as human beings influence it, seems too complicated for that. Feminist scholars in many fields have long advocated looking at things from different standpoints. At the same time, feminist science studies scholars have emphasized that the existence of multiple perspectives and starting points does not mean that all approaches are tractable or that all perspectives work equally well. Feminist science studies scholars encourage studying multiple standpoints in order to benefit from the insights that occur when one explores the ways in which different perspectives inform one other. Feminist science studies is also, nonetheless, explicit in its rejection of epistemological relativism.

Building on feminist work in other disciplines, we can teach our students to look for underlying assumptions in all scientific practices. It is also important that the mathematical and physical sciences not be presented as an unchanging body of knowledge —complete, certain, and absolute. In fact, many practicing mathematicians and scientists have a very different image of mathematics and science than does the general public. Many of them see it as a creative, intuitive, and speculative endeavor. This suggests a pedagogy that emphasizes the creative (and culturally dependent) process of actually doing science. For example, rather than merely repeating the codified and axiomatic presentation that appears in most mathematics textbooks, a pedagogy that shifts emphasis from final product to process gives the student a more accurate view of the practice of mathematics. Such approaches also have the additional benefit of being found to appeal to the minds and hearts of many previously "math anxious" students.

Those who teach mathematics, physics, chemistry, or other "hard" sciences may find it difficult to understand the relevance of social variables such as race, ethnicity, or gender to their discipline. For example, one might well ask, "What does race and ethnicity have to do with the second law of thermodynamics?" (Of course, there is nothing unique about thermodynamics; a similar question could be asked about x-rays, molecular orbitals, or the silicate rocks in the Earth's crust.) The implication of any such question is that the laws of nature are objective and free of any human bias. However, while the empirical adequacy of the law may not be in question, whether or not a given law works isn't the only substantive issue. Feminist science studies scholars are interested to know the historical and social context in which scientific laws and theories are developed. It is important for students to understand that the second law of thermodynamics is not self-evident, but evolved out of the context of the industrial revolution and, as such, is a product of that era and reflects its dominant values and the ways people were interested in interacting with the natural world.

Furthermore, as physicist and feminist science studies scholar Karen Barad points out in her article, "Agential Realism: Feminist Interventions in Understanding Scientific Practices" (1998), feminist scholarship is not limited to analyzing gender relations; rather, feminists are concerned with larger epistemological issues as well. Barad quotes Joseph Rouse who suggests that feminist approaches to science "are not simply about relations among men and women but are focused precisely on how to understand agency, body, rationality, and the boundaries between nature and culture." Indeed, feminist science studies scholars have made important contributions to scholarship about the very nature of scientific practices. They have, for example, provided empirical evidence in support of the current view that what we call "the sciences" are actually not as unified as one might think, but rather entail heterogeneous, varied, and changing sets of practices. Hence, there is no justification for presuming that the same kinds of analyses that apply in the life sciences have relevance for the physical sciences. Once again, however, this does not mean that feminists have nothing to contribute to our understanding of the physical sciences. For example, Barad's research, which uses physics as a starting point, is concerned with understanding the interaction between human and nonhuman, material and discursive, and natural and cultural factors in the production of knowledge. One of the aims of her approach is to move considerations of scientific practices beyond the well-worn traditional realism vs. social constructivism debates.

As noted above with regard to mathematics, it is important in the physical sciences to consider what is not being studied. Whose questions are we addressing when we teach science?

Which agendas are pursued and which are left untouched? What drives the topics we research? How does boxing science into the existing disciplines affect our thinking? Feminist scholarship can contribute questions such as these to the teaching of the "hard" sciences, mathematics, and engineering.

These questions also can help unleash the creativity of students who have seen no reason to study or to strive towards mastery of material that appears disconnected from their world. The pedagogical approach that many in the physical sciences use in their teaching removes the Second Law from its historical and social context, leaving behind only a group of mathematical symbols. However, the point is that this type of decontextualized teaching has gained prominence for reasons that are far from culturally neutral. The new pedagogies that seek to train students to attend to social, cultural, and political, as well as natural factors in the production of scientific knowledge can find support and a theoretical basis in the field of feminist science studies.

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