An Overview of Feminist Perspectives as they Relate to Science and Mathematics Education

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Feminism is clearly not a unitary movement. Though there is a basic desire for equality and the end of discrimination, there are many feminist groups including radical feminists, socialist feminists, Marxist feminists, lesbian separatists, women of color, postmodern feminists, feminist empiricists, and so on; all of which have a different definition and viewpoint. "Feminism is the refusal to define all women and therefore all human beings solely in terms of sex" (Castro, 1990, p. 2). It is an active desire to change women's position in society (Mitchell, 1986). A feminist believes that women suffer discrimination because of their sex, that they have specific needs that remain negated and unsatisfied, and that the satisfaction of these needs would require a radical change in the social, economic, and political order (Delmar, 1986). Feminism is an effort to bring insights from various female experiences together with research and data gathering to produce new approaches to understanding and ending female oppression (Bunch, 1983). There are several ways to categorize feminists and feminist theory, and critiques depend in part on the perspectives taken (Noddings, 1990). The goal of this paper is not to look at all the different feminist perspectives, but to look at a general view of feminism and the underlying attitude a feminist would have toward science, mathematics, and mathematics education.

Feminist theory is based on the underlying belief that we live in a male-dominated culture in which men have developed the guidelines for society. They have drawn on their knowledge, perspectives, and visions to create and construct the prevailing theories, history, and values that have become important. Even our major educational institutions were developed by men, for men. Later, when girls' schools and women's colleges were developed, they were patterned after the male institutions. The belief was that this would give women an education equivalent to that of men (Belenky, Clinchy, Goldberger, & Tarule, 1986).

Little attention has been given to the modes of learning, knowing, and valuing that may be common in women. Common acceptance of stereotypes of women's thinking as intuitive, emotional, and personalized has most likely contributed to the devaluation of women's minds and contributions. In a culture that values rationalism and objectivity, it is assumed that intuitive knowledge is more primitive and thus less valuable than objective knowledge and objective modes of learning (Belenky et al., 1986). For many women, the real and valued lessons in life did not grow out of their involvement with academics, but rather their involvement in their relationships with family, friends and teachers, life crises, and the community. Women often feel alienated in academic settings. They see formal education as irrelevant and far from their central interests and development (Belenky et al., 1986). Also, some women are "left behind" in their understanding of academic concepts because many faculty members assume that the pedagogical techniques that are appropriate for men are also suitable for women. A study by Fennema and Peterson (1987) showed that competition in a classroom did not facilitate girls' learning, but cooperative learning had a great impact on the girls' learning. Yet there are many classrooms that thrive on competitive learning situations. In order to design an education appropriate for women, we must first learn about the academic experiences of ordinary women (Belenky et al., 1986).

Feminist Theory and Science

Recently, feminists have convincingly argued that there is a masculine bias at the very heart of most academic disciplines, methodologies, and theories. Feminists are beginning to articulate the values of the female worlds and to reshape the disciplines to include the woman's voice (Belenky et al., 1986). Take for instance the academic subject of science. First, one might ask why there are so few women scientists. Science has been defined as a masculine activity of which women, because of the qualities associated with femininity, are incapable. Society has accepted science as masculine, and those values have been passed on to women.

In the 1960s there was a great deal of attention placed on the subject of women in science. The low representations of women in science, particularly in the upper levels of the scientific community, were discussed. In an article enumerating the various impediments confronting women in science, Keller (1974) suggested that the one that was

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perhaps the most powerful was the widespread belief in the intrinsic masculinity of scientific thought. These beliefs are kept alive by widely held myths about science that abound in society and are often looked upon, by women as well as men, as truths. A sample set of myths given by Keller (1983) is as follows:

1. "Science is impersonal; women are personal".
2. "Science deals with things; women deal with people".
3. "The male way of knowing in its highest development is objective, analytical, scientific investigation. The female way of knowing in its most complete sense is the mother's intuitive knowledge of her baby".
4. "Science is reason, unalloyed by feeling. Feeling is a female element while thinking is a male element".
5. "Science is 'hard' and tough-minded; women are 'soft' and sentimental".
6. "Science seeks power; women seek harmony".

(pp. 132-133)

Masculine epistemology and knowledge have an emphasis on the domains of cognitive and objective rationality, on reductive explanation, and on dichotomous partitioning of the social and natural worlds. This masculinist knowledge has produced today's science, which seeks to relegate women and women's knowledge to the realm of nature (Rose, 1986).

The epistemology of science is based on dualisms such as nature/culture, subject/object, and knower/known. The dichotomy of science leads to hierarchies and control, which is typical of our male-dominated society. Thus science has an androcentric bias and a bias in research methods. This has led to a bias in the choice and definition of problems with which scientists and science have concerned themselves (Keller, 1987). The potential for bias on the part of male scientists is also heightened by the recurring tendency to select exclusively or predominantly male samples for research. Studies are done, conclusions are made, and what has been learned from the study of men is generalized and transferred to the lives of women. If and when scientists turn to the study of women, they typically look for ways in which women conform to or diverge from patterns found in the study of men (Belenky et al., 1986).

Although feminists agree on the present masculinity of science, they have not agreed on a definite alternative. In contrast to a masculinist epistemology, a feminist epistemology evolves from women's lives and experiences. It is centered on the domain of inter-connectedness and affectual rationality. It emphasizes holism and harmonious relationships with nature (Rose, 1986).

A number of feminist critiques of science and masculinist epistemology argue that we should replace the masculinist epistemology of science with a feminist epistemology. Three epistemologies that are designed to accomplish this task have risen to the forefront of feminist theory. They are feminist empiricist epistemology, feminist standpoint epistemology, and feminist postmodern epistemology.

Feminist empiricism is a critique of science that concentrates on the exclusion of women from science and what they could contribute if they were included. It seeks equality with men and hence is considered a first generation feminism (Noddings, 1990). It argues that sexism and androcentrism are social biases and feminist scientists, men as well as women, are more likely than nonfeminist scientists to notice this bias. It assumes that the laws and methodologies of science are correct, but if attention is paid to the inequities of participation, the problems that have arisen in the conduct of science will start to be resolved. All in all, the problem lies not in science itself, but in a "bad science" - a science that is distorted by masculine bias in problematics, theories, concepts, methods of inquiry, observations, and interpretations of the results of research (Harding, 1987).

Feminist empiricism has some flaws that need to be considered. First, if strict empiricism were correct, the laws and methodologies of science would be such that the gender of the researcher would be irrelevant. But feminist empiricism claims that feminists are more likely to produce objective and unbiased results than are nonfeminists. Secondly, a key origin of androcentric bias can be found in the selection of problems for inquiry. Feminist empiricism insists that its methodological norms are meant to apply only to the "context of justification" not to the "context of discovery" where the problems are identified. Thus the attempt of feminist empiricism to reform a "bad science" has resulted in what have been called "empirical inadequacies in empiricist epistemologies" (Harding, 1986, p. 26).

A second theory that offers hope for changing science is feminist standpoint epistemology. Recognition of the incoherences of feminist empiricism led to the development of this philosophy. Feminist standpoint epistemology purports that women, because of certain aspects of their makeup, possess a privileged position that provides them with a unique perspective. Women can know the world in ways not available to men because they are less bound to the norms of science and are better able to examine it (Harding, 1986). This theory is consistent with second generation feminism in which individual qualities are embraced and assimilation into the male world is rejected.

Feminist standpoint epistemology is based on the idea that knowledge begins with women's lives and experiences. Thus multiple feminist standpoints exist, all of which are different but not necessarily disjoint. Hence

feminist standpoint epistemology allows for a multiplicity of ideas and truths (Damarin, in press).

A major defect of feminist standpoint theory is that the many ways in which women divide themselves in the world are overlooked. How can a single feminist standpoint exist in this situation? Does there need to be a feminist standpoint for every division of race, class, and culture? Or, does this mean that one person or group will dominate the whole (Harding, 1986)?

To learn about the mathematics achievement of females, we must study females in and of themselves.

The final epistemology that is at the forefront of research is feminist postmodern epistemology. This theory celebrates the diversity of women's being and expresses a profound doubt toward the universalizing of claims about existence, nature and powers of reason, progress, language, and science (Harding, 1986). Feminist postmodernism would attack the roots of masculinist science and strive for a transcendence of dualistic thought. It would use race, class, cultural differences, and gender as categories of analysis. What passes now for gender-free and objective is exactly in line with a masculine view of the world. It appears to be objective to most men because it labels men as the norm, but it leaves the women feeling excluded. Feminist postmodernism would also avoid generalizing beyond the scope of the data. Attention would be given to individuals, and thus a science that is de-centered, pluralistic, and non-hierarchical would be developed (Hekman, 1990; Rosser, 1986). Feminist postmodern epistemology is the start of third generation feminism. In third generation feminism, "women seek equality with men. . . they embrace their own special qualities and reject uncritical assimilation into the male world. . .and seek solutions that arise out of a careful synthesis of old and new questions" (Noddings, 1990, pp. 393-394).

Feminist postmodern epistemology is aware of its inconsistencies and faults and does not claim to have a "lock on truth" (Duran, 1991, p. 87). From this perspective, feminists' claims seem more plausible and less distorting since they are grounded in the solidarity of the diverse identities of women.

Though feminist postmodern epistemology seems to have the most hopeful future of the three epistemologies due to its awareness of the plethora of women's voices, it has some inconsistencies. Unlike the feminist standpoint theory, we may ask ourselves "can we afford to give up the necessity of trying to provide one, true feminist story of reality" (Harding, 1986, p. 28)?

Feminist Theory and Mathematics

Feminist theories about science in general have been well documented, but little attention has been given, in comparison, to explicitly focusing on a feminist view of mathematics. The early research in gender and mathematics was grounded in feminist empiricism. Noted researchers such as Fennema, Fox, and Sherman began by addressing the gender problem and outlining the research agendas for future, less sexist studies (Damarin, in press).

A number of studies that focus on females' achievement in the mathematics classroom have been conducted. The results of these studies have produced a persistent theme in the study of gender and mathematics. This is that females excel at lower level computational skills while males excel at higher level problem solving skills. This result gives the impression that females understand mathematics at a lower level than do males. Many of these studies were based on the need for a comparison of females to males using males as the norm. The studies tried to explain why females' mathematical achievement was not as high as males' and why females did not elect to participate in advanced mathematics courses or in mathematics related careers to the extent that males did. This male bias, however, has only compounded the difficulty of exposing the full implication of mathematics achievement for females (Fennema, 1990). To learn about the mathematics achievement of females, we must study females in and of themselves.

Introducing a feminist standpoint epistemology to mathematics would require "a willingness to abandon beliefs about the nature of mathematics and how it must be taught and learned in order to be open to the 'nature' of mathematics as it is experienced" (Damarin, in press). A major part of this experience for women takes place in general society. The relationship of most women to mathematics is constructed by the receipt of messages about mathematics. For women, a recurring message is that it is important to learn mathematics, but it is not important for women to learn mathematics. Thus a woman who continues to pursue higher level mathematics must continually reject her "natural" position (Damarin, in press).

A feminist postmodern view and movement toward third generation feminism can be seen in recent research. A study of Mr. Martin's middle school mathematics class, performed by Stanic and Hart (in press), concerned itself with both gender and race. Though this alone would be

considered first generation feminist thought or even feminist empiricism, Stanic and Hart looked past the categories of gender and race to make important conclusions about individual differences.

> We began our case study with the objective of looking at sex and race differences in mathematics attitudes and the achievement-related behavior of persistence. The fact of the black students scoring higher than the white students on the paper-and-pencil measures of attitudes and persistence notwithstanding, we found that the most productive level of group analysis required looking at sex and race simultaneously. Even this group analysis was limited to the extent to which individual students showed unique configurations of interacting characteristics, which confirmed for us the importance of considering archetypical students rather than just demographic groups. Our work points to the need to qualify group differences by studying individuals over time and attitudes and behaviors in interaction, using multiple measures of achievement (in press).

A model proposed by Reyes and Stanic (1988) concerns itself not only with gender and race, but also with socioeconomic status (SES). The goal of this model is to explain group differences in performance by using variables such as societal influences, school mathematics curricula, teacher attitudes, student attitudes, achievement related behavior, classroom processes, and student achievement. Much has been studied about the mathematical achievement of students as related to race differences, gender differences, SES, and other differences as individual entities (Dossey, Mullis, Lindquist, & Chambers, 1988). The intent of this model is to bring all of these variables together to more fully explain achievement differences and thus to attain equity for all students. As stated by Reyes and Stanic (1988), "There is clearly much work to be done to prove that group differences in mathematics achievement we now see do not reflect the natural order of things" (p. 40).

Another study that moves toward a solution by examining pedagogy was performed during the 1987-88 academic year by Zelda Isaacson (1990). In this study, Isaacson taught a mathematics course to a group of 24 women. These women were generally in their twenties and thirties and were well-educated in humanities, languages, or social studies, but not in science, technology, or mathematics. In talking with the women, Isaacson learned that many had joined the course because their life experiences had given them confidence in their practical and technical skills, but that they were much less confident in their ability to learn mathematics. Typical comments from the women were as follows. "You won't ask me questions that I can't answer in front of the whole class, will you?" "I'm not telling anyone, but I'm scared." "I couldn't stand the competitiveness [of mathematics]." "People think you're weird if you like maths [mathematics]" (Isaacson, 1990, pp. 23-24). Thus Isaacson chose the following as key strategies for the course: to encourage group work and discussion, to provide structured investigative activities, to legitimate the women's common sense knowledge, to give them confidence in their ability to learn mathematics, and to create a light-hearted classroom atmosphere.

Throughout the course the women were asked to reflect on the course and themselves as learners of mathematics. By the end of the course, the typical comments from the women became positive. "It [group work] was useful because we could argue until we agreed (or agreed to disagree) on a point." "It was nice to be able to share ideas." "The way we're being taught now is . . .I'm really enjoying it - it's so much fun!" "I enjoy mathematics and look forward to continuing with the subject" (Isaacson, 1990, p. 27).

Mathematics classes need to become places where originality, independent and creative thinking, and imagination are valued. Individuals' contributions and ideas must be welcomed, not rejected. Common sense knowledge should be validated and built upon, rather than relegated to the category of irrelevant and unimportant knowledge. All this implies using an investigative open-ended approach whenever possible. Mathematics classrooms should also be places where pupils come to have fun and to be intellectually stimulated rather than to be filled with rules. . . .

Fear and anxiety are wholly negative, damaging emotions that should have no place in mathematics classrooms. Teachers need to be fully aware of how easy it is to engender these feelings - and how important it is, instead, to strive to create a relaxed supportive, non-competitive environment where pupils can gain and maintain confidence in their mathematical abilities. And last, but not least, mathematics classrooms need to be places where talk is encouraged and where collaborative, cooperative work is the norm (Isaacson, 1990, pp. 26-27).

From the study of these 24 women and their trials with mathematics, implications for classroom practices were formed by Isaacson. These measures would improve mathematics classrooms for all pupils, but especially for girls (Isaacson, 1990)

In a 1987 study at Potsdam College in New York (Rogers, 1990), it was concluded that in an environment that is genuinely open to and supportive of all students and in which the style of teaching is true to the nature of mathematical inquiry, women are attracted to mathemat-

ics and are just as successful as men.

Though no solutions are offered, research like this is beginning to move closer to outlining a clearer picture of a feminist view of mathematics teaching. These studies bring me to ask the questions "Is there truly a feminist mathematics or just a feminist pedagogy? Is mathematics itself discriminatory or does the discrimination lie in the attitudes of society towards women in mathematics?"

It is my opinion that mathematics is a beautiful science and no longer a male domain. Girls and women need to be told that they can succeed in mathematics. Research needs to focus more toward teaching methods, the ideas of students in the classroom, and how well teachers are able to identify these ideas, interact with them, and help students improve on them (Davis, 1992). If the ideas presented by Isaacson (1990) and Rogers (1990) became the norm in every mathematics classroom, I believe that mathematics would become as popular as chocolate!

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