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Toward Thinking Feminism and Mathematics Together

The boundary separating mathematics from women's studies and feminist theory, while not as forbidding as a prison wall, is nonetheless substantial and rarely crossed. Not since 1978, when feminist activist Sheila Tobias both published her best-selling book *Overcoming Math Anxiety* and coauthored an article about the evaluation of women's studies programs (Guttentag et al. 1978), has there been an active feminist scholar with one foot on each side of the divide. Thinking mathematics and feminism together requires dealing with this boundary. In a different context, Donna Haraway argues "for pleasure in the confusion of boundaries and for responsibility in their construction" (1991, 150). Rather than trying to straddle boundaries separating women from mathematics, mathematics from gender, mathematics from feminism, and so on, my goal is to reveal and employ (and enjoy) their confusions and to suggest responsible possibilities for bridging the divides.

In this article I interrogate with pleasure some of the boundaries inscribing discussions of women, gender, and mathematics among various scholars in the academy and the boundary separating women's studies and mathematics, in the hope that women (and feminist men) from across these areas can find common ground. While some feminist ideas have permeated the boundaries surrounding the discussions of mathematics, the situation is much as it is with physics: feminist content is "meager" (Bug 2003, 889). Moreover, the theoretical constructs developed through decades of feminist analysis and scholarship are largely absent from discussions of women, gender, and mathematics. After considering these constructs, I meditate upon the nearly total absence of discussions of mathematics within the literatures of feminist theory and interdisciplinary women's studies. Finally, I consider what might be involved in reworking some boundaries in order to bring the ideas and analyses discussed together to understand and promote the position of women.

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Choosing to focus on adult women

More than three decades ago, Lucy Sells investigated the availability of various graduate programs, academic majors, and career paths to women at the University of California, Berkeley. What she found was that mathematics served as a "critical filter" (1978). Not only were women ill prepared for the study of advanced mathematics, but their lack of mathematical preparation operated as a barrier, filtering them out of most advanced educational opportunities. With the rise of second-wave feminism, Sells was but one of a growing number of mathematicians, educators, psychologists, and others who studied mathematics and sex across many contexts. Over the decades this work has mushroomed, and today there is a huge body of literature on the topic. While women, gender, and mathematics is the singular focus of some studies, many studies focus more generally on women and issues of gender in the STEM fields (science, technology, engineering, and mathematics).

If there is a sound-bite summary of these studies, it is "women in the pipeline," a phrase that denotes the retention and progress of women through the course of study of mathematics from entering secondary school to receiving a PhD. Currently, pipeline data indicate that there are no longer significant sex differences in the study and mastery of mathematics through the baccalaureate level. Only at the graduate level and beyond are there differences in the numbers of women and men studying mathematics; there, the presence of women decreases dramatically. Thus, thirty-odd years later, researchers concerned with women, gender, and mathematics are focusing their attention at advanced levels, just as Sells did when these studies began. Indeed, as I was finishing this article, the National Academy of Sciences (Committee et al. 2007) issued the report *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*, based on a study conducted at eighty-nine Carnegie category one institutions. The authors argue that the success of women in mathematics graduate programs and faculty positions is limited by biases against them and that institutions must be changed. Although there has been some progress for women and there is much in the report that is new, there is also a sense of déjà vu when one compares some of it with parts of Mary Gray's (1972) report on a panel presentation on Women in Mathematics at a meeting of the Mathematical Association of America more than a third of a century ago; both comment on the erroneous perception that qualified women mathematicians are scarce and argue for increasing their visibility. Responses to the current report, such as *New York Times* columnist John Tierney's op-ed piece "Academy of P. C. Sciences" (2006) are further reminders that in many places the societal

perception of women, gender, and the sciences, including and perhaps especially mathematics, has changed little since the 1970s.[1]

Academic studies of women, gender, and mathematics

The extensive literature concerned with women and mathematics has four basic components or genres: studies within the field of mathematics education, studies in social or differential psychology, institutional studies of the conditions of women in mathematics, and biographical studies of women mathematicians. Each of these genres can be characterized as operating well within the norms of its disciplinary base. Although these genres are distinct, each genre takes as truth the primary findings of the others, borrowing both conclusions and methods as they are useful.

Although some researchers and writers in each genre demonstrate, or at least claim, familiarity with feminist theories and literatures, by and large their work in these mathematics-related areas does not appear to be shaped by feminist theories or by attention to interdisciplinary women's studies. Thus, major developments such as the deconstruction of male-female and sex-gender dichotomies and the consideration of gender as performance are largely outside the mainstream literatures in each of these genres. Nor have any of these genres used the literatures of women's studies or cultural studies to deeply address issues of diversity among women in mathematics or intersectionality of gender with race, class, age, and other categories of difference. When race is considered, the discussion is largely statistical and perfunctory. Although there are some approaches and techniques (and researchers) that cross two or more genres, each genre makes unique contributions to the discourse of women, gender, and mathematics.

Studies in education

Mathematics education is a specialized field within the broader study of education at all levels. Although it is well represented in major educational research organizations and publications, the primary work of the field is carried out within the vibrant international community of mathematics education researchers and communicated in national and international gatherings and publications devoted solely to mathematics education.

[1] Tierney is a regular columnist of the *New York Times*. In this column, he refers to *Beyond Bias and Barriers* as a "political tract" and criticizes the researchers for not following "the scientific method." He then cites some "experts" of his own in support of his quarrels with the findings. A major point of his criticism is that the panel of researchers is predominantly female (2006, A23).

Many, if not most, researchers in this field have taken graduate-level courses in mathematics as well as education. The mission of the research field is disciplined inquiry into the processes of teaching and learning mathematics, with an underlying goal of increasing mathematical understanding and performance across all levels of mathematics and all populations. As a formally organized field, mathematics education is approximately the same age as women's studies; the *Journal for Research in Mathematics Education* (*JRME*), the major U.S. research journal, was inaugurated in 1969, just six years before *Signs* appeared. At that time, in the heyday of the second wave of feminism, interest developed among many mathematics education practitioners and researchers in both studying and improving the conditions girls and women in mathematics experience. Research on predictors of girls' success in and attitudes toward mathematics, curricular issues, and other school-related variables emerged and grew in this period. In 1994 Elizabeth Fennema, a "founding mother" of these studies (and mentor to many researchers who continue her work), summarized twenty-five years of research and its successful contributions to changing the mathematical landscape for girls in elementary and secondary education. Writing with Laurie Hart, she argued that two areas of academic work would be of major influence on the next advances in the understanding of gender and mathematics: cognitive science and feminist theory (Fennema and Hart 1994). In the decade following their prediction, *JRME* published exactly one article (Walshaw 2001) based in feminist and postmodernist theories. If Fennema and Hart are correct in predicting an influential role for feminism in mathematics education research, progress has been slow at best. In other ways, *JRME*'s and other mathematics education journals' approach to the study of women, gender, and mathematics remains unchanged; in particular, the representations of sex, gender, and women are dated at best.

Publication policy makers and journal editors, among others within mathematics education and related fields, resist any distinction between biological and social phenomena (sex and gender, respectively), and consequently they refuse to recognize that these operate jointly in a sex-gender system as described decades ago by Gayle Rubin (1984) and other feminist scholars. Salient among these refusals is the insistent labeling of research that categorizes persons biologically as gender studies.[2] The continuing proliferation of gender studies characterized by the search for sex-specific

[2] This has not always been the case. The studies of Fennema and Sherman (1977, 1978), which are widely cited as key papers in the founding literature of this area, were published as studies of sex-related differences.

differences in mathematics-related behaviors operates to reify gender as a biologically based binary variable and to foreclose other kinds of gender studies in mathematics education. Similarly, ethnographic and other qualitative studies of gender and math in school settings tend to report on the behaviors and speech of persons sorted by sex rather than to examine the many ways in which mathematics is used in gender performance.

Moreover, within mathematics education research, use of the term "gender" still signals attention to women and serves as both code and container for attention to women, girls, females, and the feminine in the definition of research questions and variables; identification of research subjects; and conduct of the research. Only in the past three or four years has this begun to change in response to the trend toward studies of masculinities within the broader field of education. In this regard it is noteworthy that the plural framing of masculinities invites and requires attention to issues of race and class when considering boys and men in educational settings; this stands in sharp contrast to the absence of attention to racial, ethnic, or economic diversity in most literature on gender, coded as female, and mathematics.

The operations of othering buried in these language games are complex and slippery. Many studies of women and mathematics are not studies of gender; for example, studies uncovering the lost history of women who have done mathematical work over the centuries and recognizing their contributions to the field may not consider gender at all.[3] Through the discourse of mathematics education, however, "woman" becomes (once again) other to mathematics because "gender and mathematics" and "women and mathematics" are read and treated as equivalent. These discursive moves operate in two interrelated and oppositional ways simultaneously; they define a niche for research in which the focal interest is females and mathematics, and they build discursive barriers between sex-gender-women and mathematics. Thus, the body of literature on gender and mathematics itself functions for the collective of women in much the same ways that everyday experiences with mathematics have operated in the lives of individual women. Space does not permit much discussion of the latter, but it is no secret that millions of women have had conflicting experiences with mathematics as they operated in what Diana Erchick calls the "space/barrier" (1996) to indicate that women's and girls' mathematical opportunities, or spaces, are often framed in such a way that they are always already barriers to success.

In a time when all modes of categorization, and particularly all binary

[3] See Kohlstedt and Longino (1997) for a discussion of related issues across the sciences.

systems of classification, have undergone and continue to undergo displacement and rethinking across many fields of study, it is hard to know what to do with this set of issues. It seems unlikely that the mathematical experiences of girls and women will change until the arguments for a sex-gender system are understood and inform academic research; equating gender and sex tends to foreclose interrogating the ways mathematics operates in the social construction of gender and gender roles as well as the ways normalized gender roles influence behavior in situations involving use of mathematics. Although these issues are conceptually dated in many venues, it is not clear how mathematics education researchers could understand and engage with deconstruction of differences they do not see—or, if they see them, refuse to recognize. Until there is some change, the reification of sex differences (labeled as gender differences) in the mathematical behavior of males and females is likely to continue.

Studies in psychology

In their recent *Signs* review essay, Abigail J. Stewart and Andrea Dottolo (2006) point out that for at least the past twenty years feminist psychology has had little interaction with women's studies and feminist theory. They argue that the work of Sandra Bem breaks from the disciplinary boundaries that inscribe the work of most feminist psychologists and signals a potential for the convergence of feminist psychology and interdisciplinary women's studies. In this context, it is instructive to consider what Bem (1993) has to say about gender and mathematics in *The Lenses of Gender*, her revisioning of sex and gender within psychology. She states: "And even Camilla Benbow's [findings] may have some validity: males may be better at higher mathematics than females because they have some special biological ability to reason mathematically" (37). With this remark, Bem commits what would count as heresy among many educators and mathematicians concerned with the place of women in mathematics.[4] But Bem goes on to say: "And yes, men might turn out to have a higher aptitude for mathematics than women on the average, but that would not explain why so many more women have a high aptitude for mathematics than have careers requiring one" (38). Through this and related discussions,

[4] Benbow and her research have been vilified within many communities of women concerned with mathematics. In the 1970s she coauthored an article in *Science* that argues that women are biologically inferior at high levels of mathematics (Benbow and Stanley 1980). This article was widely publicized and precipitated much heated discussion. Since then Benbow's work has continued in the same direction. In 2006, President George W. Bush named her to his National Mathematics Advisory Panel; in response, the Association for Women in Mathematics led an energetic but unsuccessful petition drive demanding her removal.

she argues for a shift from a lens trained on biological differences to one clearly focused on social and cultural issues.

Bem's argument clearly moves beyond the sticking point of sex-gender discourse discussed above, but a review of psychological literature relevant to women, gender, and mathematics reveals that extensive study of sex differences continues, albeit in the context of a recognized need to avoid the biases they can entail. Many differential psychologists recognize that quantitative study of differences among individuals based on gender, race, class, ethnicity, sexuality, and other social variables is shunned by colleagues because of its well-documented role in the history of prejudice and oppression. While social and behavioral science researchers often reject earlier overtly racist or sexist studies as flawed, contemporary research is not free of such biases (Cole and Stewart 2001). Moreover, even in more benign ways, the identification of sex-gender (or race) differences tends to serve the interests of the dominant group, if only because the groups in power produce the constructs on which the measurements are based. Nonetheless, psychological studies of sex proliferate (Eagly 1995), and mathematical ability, together with statistically related characteristics of individuals, seems to have a secure place in the roster of factors regularly examined by those who seek to identify and study intellectual or mental differences between the sexes. Thus, even when researchers announce that a mathematical performance gap has been closed, some researchers seek sex differences in subareas of the mathematics in question or in subgroups of the general population.

Psychologists Rachel Hare-Mustin and Jeanne Maracek (1988) argue that avoiding the biases implicit in attention to differences can introduce other biases, including those entailed in assumptions of sameness. Clearly, sameness and difference (of the sexes), though focused in opposite directions, are not disjunctive constructs but are intertwined in complex ways. As Bem and many others have pointed out, overlapping normal curves often show both sameness and difference, and the prioritizing of a small but statistically significant difference over a large shared variance is a choice researchers often make when interpreting data. When this is the right choice, and when not, is an important question. Elizabeth R. Cole and Abigail J. Stewart (2001) discuss this matter at length, stressing the importance of attending to the experiences of those studied, not just their performance or status on various measures. Although these researchers are concerned with the effects of experience on mathematics tests and test scores, others direct their research toward the long-term effects that these tests and scores can have on the lives of women.

An extensive literature review by Florence Geis (1993) and the writings

of Virginia Valian (1999, 2005) provide us with the main points of this empirical work. As demonstrated in the work of Geis and her colleagues, measured gender differences—even very small gender differences—operate as a self-fulfilling prophecy in the sense that both male and female evaluators overattribute to individual members of each sex those characteristics that are statistically associated with the sex.[5] This finding applies to all the many and diverse variables for which it has been tested, including so-called objective characteristics such as height. Judges use their knowledge of (or beliefs about) population differences in the distributions of attributes when making judgments about individual members of the population. What this means in the context of gender and mathematics is that societal knowledge or belief that males outperform females contributes to small (but real) overestimates of the quality of performance of males and comparable underestimates of the quality of performance of females. These findings apply to all judges, including professors and employers. Such over- and underestimates of individual mathematical ability compound in ways analogous to interest on loans or savings, and what might begin as very small differences in judgment of mathematical ability can accumulate and build up to become very large differences in the experiences of women engaged in mathematical work.

In summary, the psychological literature on women, gender, and mathematics has two distinct strands, the first continuing a tradition of probing and documenting sex-based differences in various aspects of mathematical performance and the second investigating how knowledge of group differences affects judgment and thus experience of individuals. Both lines of study are influential beyond academic psychology.

Institutional studies

The condition of women in mathematics is examined on a regular basis by a number of bodies, including the American Mathematical Society (Kirkman, Maxwell, and Rose 2006a, 2006b), the National Science Board (2006), and the National Academy of Sciences (Committee et al. 2007). Relying on data provided by educational and scientific institutions, these studies are largely statistical and report numbers of females and males in a variety of capacities. The studies for the American Mathematical Society are the most extensive, naming persons awarded PhDs, examining the job market for women and men, and reporting the numbers of scholars of each sex who present papers at conferences, among other data. In addition

[5] Here I follow Geis and Valian who use "gender differences" rather than "sex differences." Apparently usage varies across specialties within psychology.

to their importance for tracking progress and sometimes motivating institutional change, these reports contribute to the general discourse on women and mathematics in a number of ways. First, they serve as background information for all the other studies. Despite the considerable progress of women, according to most of the markers identified in these studies, the data are used most often to document the "truth" of women's lesser presence or performance in mathematics, a truth that justifies further inquiry. That is, these reports provide continuous focus on sex differences. Second, there are mixed motivations for these reports. While equity and diversity are certainly concerns, the primary stated motivations have to do with assuring global leadership in scientific progress and national security. In addition, there is an underlying concern over the large numbers of foreign nationals among advanced students in mathematics. The reports are therefore shaped by a number of competing issues, and the interests of women and of gender equity often become lost in the other concerns. Third, recommendations from these reports are directed to institutions and intended to effect top-down changes in institutional practice. Such changes may or may not be attentive to the needs of women in any particular institution. In general, what is absent from these reports is careful analysis of the lives and experiences of women mathematicians, to which I now turn.

Women mathematicians

Turning to the lives of women with doctorates in mathematics, I begin by noting that, in the view of several women mathematicians (e.g., Ruskai 1995, 1997; belcastro and Moran 2003; also see Longino and Hammonds 1990), the study of gender and mathematics has been at best irrelevant and at worst hostile to the understanding of their lives. As Mary Beth Ruskai points out, the study of gender by educators and psychologists has been largely a study of female failure to succeed in mathematics. If true, this is a serious matter; an understanding of gender and mathematics that has no place for successful women is obviously seriously flawed. Fortunately, there is an increasing and highly interesting and informative literature of interviews, biographies, oral histories, and ethnographies of mathematical women that serves as source material for understanding these lives.

The oldest and most common reporting of the lives of women mathematicians casts their biographies in and against the sex-gender system, focusing on the ways their careers are shaped by their roles as daughter, wife, and mother (or by resistance to these roles) at least as much as the reports attend to the women's practices of and contributions to mathe-

matics. When women have been included in collected profiles or brief memoirs of mathematicians, the differences between men's and women's stories are striking. For example, three women's stories are included among the twenty-five in *Mathematical People: Profiles and Interviews* (Albers and Alexanderson 1985). Here, Mina Rees is interviewed primarily about issues related to gender and family and her discussions of these issues with other women in mathematics. Olga Tausky-Todd's entry is a previously published autobiography focusing at length on how her opportunity to become a productive mathematician in America unfolded and on the persons (primarily men) who encouraged her and helped shape her career. Constance Reid, a writer of mathematics for laypersons and of biographies of mathematicians, is asked briefly how a "nonmathematician" (271) came to do this work and then about her perceptions of the male mathematicians whose biographies she wrote. Thus, these three profiles focus at least as much on men as on the lives of the featured women: men as family members, as mentors, and as subjects of research and writing, respectively. In contrast to these, the twenty-two life stories of male mathematicians included in this impressive book are presented with reference to childhood precocity, mathematical challenges and accomplishments, recognitions and awards, and interactions with other mathematicians. The difference in approach and content is palpable, but it is also familiar: it mirrors the findings of Dorothy Nelkin (1987) in her research on the journalistic representation of women Nobelists as homemakers, cooks, mothers, and wives, with little mention of the nature of their work and scientific contributions. Such discourses about women in mathematics and science, based in a normative reading of their lives, may be useful instruction for young women on how to make it (more or less) in the male world of mathematics, but their larger function is to assure readers that women in mathematical sciences are fundamentally "real women" more than they are mathematicians and scientists. Such profiles separate women from mathematics even as they purport to celebrate their presence within it.

This familiar discourse of women as wives, mothers, and professionals is continued in more contemporary reports of research on the lives of women in mathematics. However, there is an important radical twist to this continuity. Claudia Henrion (1997) and Margaret Murray (2000a, 2000b) read the lives of women mathematicians against the common mythology of what it takes to be a mathematician. Both Henrion and Murray report on the lives of particular women who earned doctorates in mathematics, showing that in their lives the personal and professional are intertwined in multiple ways. Using the lived experiences of women

mathematicians as counterexamples, these researchers demonstrate the fallacies of the commonly held myths that mathematicians are (almost necessarily) white males who work in isolation, who do their best work while young, and who refrain from political entanglements. Henrion's work is the more extensive of the two in that she supplements data from her interviews with women who are well-known, successful mathematicians with related data, analyses, and arguments that contribute to the (hoped-for) demise of all of these myths. Both Henrion and Murray make a particularly strong case against the myth that mathematics is the work of the young, a myth that has operated against women's acceptance into mathematics, often following—or in prediction of—delays, including those related to marriage and childbearing.

An interesting and important point in Murray's oral history data is the refusal of several women in her sample of twenty mathematics PhDs to identify themselves as or to consider themselves to be mathematicians. For some this choice is based on strategic avoidance of the need to explain themselves to others outside mathematics (see Damarin 2000), but this is not always the case. One woman who had "published nearly seventy articles and books and made substantial contributions to differential equations, nonlinear analysis, and mathematical biology" states: "I don't think I ever identified myself as . . . an anything. . . . I'm pretty sure that I never think that I am a mathematician" (Murray 2000a, 86). Another successful mathematician states: "I didn't even think of myself as a mathematician—I didn't think of that word for myself . . . [until] the mathematics I was doing was somehow, finally, flowing inside me" (87).

Complementing and extending this work, Leone Burton's (2004) study of seventy mathematicians (thirty-five female, thirty-five male) focuses on their understandings of what mathematics is, their views of the development of mathematical thought, and their practices of mathematics. Gender is a major focus and factor in Burton's considerations throughout the book, and one of the concluding chapters addresses the construction of the mathematics community of practice as a male domain. Burton cites and expands on Murray's work, adding the observations of her female participants that the field of mathematics is a steeply graded one in which there is continual competition for one's place in the linear ordering of the hierarchy. The difficulties many women find in negotiating even the lowest rungs of this ladder are evident in their comments; in contrast to the persistent concerns expressed by women, Burton notes that "a male participant values the very atmosphere that the females were regretting" (166). Despite the difficulties they cite, the women in Burton's study did become mathematicians, but several comment on their marginal positions.

One states: "I consider myself a mathematician because I lecture and research in mathematics and I suppose that by definition makes me a mathematician. But I have met people whom I consider to be 'real' mathematicians and I am not one of these people" (164).

Murray presents such lives and statements in contrast to a quotation from distinguished mathematician Paul Halmos regarding what it means to be a mathematician, a position he claims is shared by many. Toward the end of his "automathography," Halmos states that to be a mathematician "you have to be born right, you must continually strive to become perfect, you must love mathematics more than anything else, you must work at it hard and without stop, and you must never give up" (1985, 400). He goes on to clarify some of these points: in particular, he states that a mathematician must love mathematics "more than family, religion, money, comfort, pleasure, glory" (400). And he asserts that these requirements are practical realities and not simply offered as advice; moreover, he has known "many, great and small" (401) who meet this description of a mathematician. Some mathematicians are clearly in agreement with Halmos, but in the absence of a careful study, it is impossible to know how common these beliefs are.[6] Discussion of the lives of women in mathematics provides little indication that they share in Halmos's beliefs; indeed, many of these women, including some well-known, highly respected mathematicians, discuss devotion to family, joy in child rearing, and time sharing or deferment of mathematical activity during their children's early years.

In sharp contrast to the recounting of women mathematicians' family relations and obligations, in the brief "Overture" to his automathography, Halmos states: "Sure, I had parents (two), and wives (two, one at a time, the present one for forty years), and cats. . . . All that is true, but it's none of your business—that's not what this book is about. The book is about the career of a professional mathematician from the 1930s to the 1980s" (1985, n.p.). Thus, Halmos states directly what is implicit in

[6] That Halmos's beliefs are shared by more than a few mathematicians becomes evident frequently when the topic of gender and mathematics is presented and discussed in colloquia and other formal gatherings of mathematicians. On one such occasion (February 1992) a mathematician (approximately forty years old) responded to presentations by two women mathematicians and myself by repeating the biblical story of Abraham's willingness to sacrifice his son Isaac should God require it. Creating an analogy between this story and the demands on a mathematician, he asked whether a woman would be willing to sacrifice her child in order to pursue mathematics. Although no one chose to pursue this line of discussion, around the room many heads nodded as if to second his rhetorical question. Other occasions have evoked similar comments and discussions, though the metaphors have been less provocative than the story of Abraham and Isaac.

Donald Albers' and Gerald Alexanderson's profiles of male mathematicians: mathematical interests and performance, relations with other mathematicians, and opportunities to pursue mathematics are the only matters of relevance to being a (male) mathematician.[7]

In the discourse of gender and mathematics, the classification of persons by biological sex is a major and exceedingly powerful move. While it is not surprising that the label "sex" should have an effect on the understanding of an area labeled "gender," the strength of the effect of sex in the ordering of domains as exclusive as "PhDs in mathematics" is startling. Differences in profiles and biographies of male and female mathematicians are totalizing in their effects; the mathematical lives of male mathematicians are presented as independent of family and other relations and obligations. As Halmos states, the latter matters are "none of your business" when considering the career of a mathematician.[8] But, in studies of the careers of women with doctorates in mathematics, these matters are not only our business; they are central to it. In short, a second divide between the sexes becomes evident: male mathematical lives are considered totally outside the social construction of sex-gender roles and relations, while lives of females accomplished in mathematics are presented as totally within them.

It is in the context of this discursive separation that women with PhDs in mathematics are frequently seen to refuse the label "mathematician" (see Murray 2000a, 2000b). This refusal mirrors the discursive ordering through which they are multiply separated from mathematics: first, by the mythologies of what it takes to be a mathematician and, should they succeed despite the myths of separation, second, by discursive positioning of their lives as always already to be viewed as gendered, not mathematical. Historically, at least, other discursive practices have both continued and contributed to the separation of women from mathematics; the paternal genealogy practices in which new PhDs are identified as sons of their advisors and many can trace their lineage back through several generations of "grandfathers" is one interesting example. Here, the ceremonial appropriation of language and relations originating in and central to the sex-gender reproductive domain furthers the separation of women from mathematics.

The meaning of the term "mathematics" is generally considered within

[7] In at least one later interview conducted in 1990 (Albers 2004), Halmos is a bit more forthcoming regarding his personal life and provides pictures as well.

[8] In recent years, the personal lives of mathematicians have been presented in popular books and movies. For a discussion of some of these, see Damarin (2000).

the framework of an assumption that mathematicians (perhaps accompanied by some philosophers of mathematics) are the arbiters of what constitutes the content of the field. Based on her study of the history of mathematics, mathematician Bonnie Shulman (1996) discusses points at which decisions regarding the future direction of the field were made, and she argues that these decisions were made in ways that were consistent with patriarchal (and otherwise hegemonic) assumptions about the world. A question to ponder is whether (and how) a woman today, even one holding a PhD in mathematics, could successfully introduce a different direction in mathematical thought and practice, particularly a direction of feminist interest.[9] An acceptance of her work as mathematics would require a full acceptance of her as a mathematician. She would need to defy the mythologies that separate women from mathematics and pass the "Halmos test" for loving mathematics more than anything else in life. In particular, she would need to love mathematics more than the feminist interests that inspire her work in this new direction. This seems to be an untenable position. In the discursive ordering of the world described above, "mathematicians" and "gender interests" operate as disjointed. In this context, persistent attention to a feminist (gender) concern is contrary to loving mathematics more than anything. That is to say, love of mathematics more than anything must trump feminist and any other related social-political interests.

Women and mathematics: Absent from women's studies

If studies of women, gender, and mathematics conducted by mathematicians, psychologists, and mathematics educators have paid scant attention to advances in feminist and cultural theories, neither have scholars in feminist theory, feminist science and technology studies, or interdisciplinary women's studies paid much attention to mathematics. This is not to say that there is no mention of mathematics within these literatures but rather that feminist theorists have not addressed mathematics at a

[9] The direction in which feminists might take mathematical work cannot be known in advance. Attempts to reduce the complexity in the findings of feminist social research without turning to probability and statistics might lead to new ways of thinking about quantity and spatial relations, for example. Similarly, feminist ecological concerns might lead to new modes of representing and simplifying complex interrelationships among factors. Two decades ago, in relation to her epistemological considerations of the female body, Luce Irigaray suggested a need for a mathematics of "the partially open, with wholes that are not clearly delineated" and other constructs that are close to but not included in the work of mathematics (1987, 76–77).

fundamental level comparable to the ways in which they have taken on the humanities, social sciences, and, more recently, biological and physical sciences and technology, challenging the legitimacy of their authority, expanse, and power. The literatures of feminist science studies take on not only the ways in which women have been (and are) excluded from the scientific endeavor but also the ways in which this exclusion plays out in the biased development of science. Feminists have put the very nature of science under scrutiny. Similarly, feminist studies of technology have uncovered multiple ways in which gender and technology each play out in the social construction of the other as well as ways in which individual technologies have been shaped by the gender assumptions (in addition to race, class, age, and other assumptions) encoded in their design. Haraway's call for socialist feminists of the 1980s to understand the power of today's technologies and to get involved in their shaping has inspired a great deal of work throughout cultural studies, including the development of cyberfeminism. With few exceptions, most notably Shulman's analysis of the masculine history of mathematics, there has been no comparable feminist critique or claiming of voice and power with respect to mathematics. There seem to be at least three reasons mathematics has escaped this critique: the special status accorded mathematics in many discourses, a lack of clarity or agreement as to the nature of mathematics, and the ways mathematics operates as a marker in the lives of women.

Mathematical truth seems to have been accorded a unique status in many venues. The postmodern challenges to truth and authority do not extend to mathematics in any clear way; Michel Foucault, for example, writing in *The Archaeology of Knowledge*, specifically exempts mathematics from his critique of the sciences (1972, 188–89). Moreover, mathematics is basically ignored in many feminist science studies articles and books. In others the word "mathematics" appears on only a few pages (e.g., Nelson 1990, 149–54) and seems to have been drawn into the discussion only for the purposes of resisting its exclusion. Edited volumes of papers on women in science sometimes address mathematics in a focused chapter, most often a chapter that is more pedagogical than mathematical. Some feminist and/or postmodernist discussions of science include mathematics as an extreme case that proves or emphasizes some point or argument relating science to the social world; in such cases the word "even" typically signals the extremity of mathematics. For example, Sandra Harding states: "Even standards for mathematical proof have been shown to be tied to practical projects" (2004, 38), and Foucault remarks: "Even historians of mathematics are now beginning to study the history of their institutions" (1998, 283).

Mathematics is, of course, distinguished from science in our education systems, both in the structure of the curriculum and in the nature of the desired learning. Not the real world but the axiomatic structure of mathematics drives the curriculum, and the fundamental facts of arithmetic and geometry are learned and largely accepted as self-evident truths (e.g., $a + b = b + a$; two points determine a line). The self-evident truth accorded axioms is inherited by the more complex mathematical statements through chains of inference such that a leads to b, b leads to c, c to d, and so on. In this context, in which all mathematics (whether understood or not) is considered to inherit truth from the axioms, any challenge, including the idea that there could be some relationship between feminism and mathematics, is most often met with consternation and frequently a comment on the order of "yeah . . . and for feminists $2 + 2$ won't be 4?"[10] Among the mathematical "truths" in the repertoire of most high school graduates is the statement "you can't add apples and oranges." This is an interesting statement in that it is patently absurd in the real world of grocery shopping and fruit salad, but it shapes the learning (and perhaps the confusion and some distrust many students have) about how mathematics is applied to solve problems. This special status of mathematics, which includes its universal truth and the expectations of not understanding on the part of many feminists when confronted with mathematics, forms a barrier to feminist work.

A second possible reason mathematics has not been subject to the same degree of feminist analysis has to do with ambiguity about what it is. For many and perhaps most adults, mathematics is closely associated with arithmetic, geometry, and perhaps calculus, precisely the aspects that mathematician G. H. Hardy (1940) and others exclude from "real mathematics." For many social scientists, probability and statistics make up the relevant body of mathematics. Mathematicians and philosophers of mathematics have devoted a great deal of discussion to the question of what constitutes mathematics and have written much that is interesting (e.g., Hersh 1997) but have derived no definitive definition. Lack of access to a clear understanding of what exactly mathematics is makes it impossible for most cultural theory scholars, including feminists, to engage in discussion of it. Whatever mathematics is, as noted above, mathematicians are the recognized authorities, and they determine what gets counted in.

[10] Although I have no formal documentation for this, I have encountered this kind of response regularly in teaching and have talked with others who have met similar responses to the suggestion that there might be any relation between gender and the content of mathematics.

How does mathematics operate as a marker in the lives of women? Several ways are discussed above, but these do not constitute the whole story. Qualitative research in which girls and women have been interviewed about their experiences with and attitudes toward mathematics reveals that many have been emotionally scarred by their experiences with mathematics in school.[11] When queried about mathematics, mature women often reveal the depth and longevity of their wounds, sometimes with tears and often with a certain reluctance to discuss them. The primary feelings expressed by many of these women are incompetence in the face of mathematics, reluctance to engage with it, relief that they are free of it, and, in many cases, feelings of guilt that they were able to succeed in mathematics without really understanding it. In the absence of any current need to deal with mathematics or expectations of doing so in the future, such feelings are likely to create a barrier to engagement in the social or feminist study of mathematics.

In summary, just as the educators, psychologists, mathematicians, and institutional study groups that have considered women, gender, and mathematics have stayed remote from feminist theory and women's studies more generally, feminist scholars have tended to keep mathematics at a distance, for some credible reasons. But there are possibilities for change.

Toward a place for mathematics in women's studies

What I have attempted to do in this article is to sketch briefly several ways that women and mathematics come together in various academic discourses. In this final section, my goals are to draw some conclusions and raise some issues that might further feminist study of mathematics, support the growth of a more comfortable place for mathematics within women's studies and feminist studies of science, and perhaps contribute to improvement in the position of women in mathematics. Several relevant themes emerge from the previous sections: language and discourse, agency, and feminist epistemologies and mathematics.

Issues of language and discourse emerge in all the sections and analyses of this article. The restrictions that education journals place on the use of terms related to sex and gender, the ways that discourses of women's mathematical inferiority function in judgments that in turn increase perceptions of women's inferiority, the terms with which women mathematicians do and do not describe themselves, and the discursive framing

[11] Buerk (1983); Erchick (1996); also see papers in Rogers and Kaiser (1995) and Schmittau and Taylor (1996).

of mathematics as extreme or exceptional come together in a single theme. The power of language in the framing of women's understanding and experience of the world is a long-term staple of feminist analysis and activism. The ways in which women are simultaneously included and excluded by the use of terminology in discourses of women and mathematics is reminiscent of the use of male pronouns as universal. With the term "mathematician," however, the problem is the reverse; the term is too restrictive, and the solution must be sought in strategies of greater inclusion, that is, in the claiming of the term for all practitioners of mathematics. Such a move would be consistent with the usage of terms such as "writer" and "musician": to some extent a person can simply claim them. Within these identities, there are qualifications and differentiations indicated by adjectives such as brilliant, weak, amateur, inactive, struggling, and so on, but the boundary separating writers from nonwriters is amorphous. Currently, the term "mathematician" functions as a fence enclosing a very small group, predominately males; this group controls not only its own membership but also what counts as mathematics. Challenging rules of discursive membership in elite, powerful groups is a consistent goal and strategy of equity movements and would seem essential here. But claiming "mathematician" as an identity in the world at large is a difficult move, especially for women or members of other marked categories. The category "mathematically able" is itself marked as deviant in many parts of society, including parts of the academy, and its members are often excluded from full recognition in other groups (Damarin 2000). In this context, we might rethink the framing of women mathematicians as "women" more than "mathematicians" and ask whether there is an opposing dynamic at work when those who work in disciplines outside the sciences deal with those in the marked category "mathematically able." Any coming together of women's studies and mathematics will require assurance that women mathematicians are accepted as being fully women and fully mathematicians by both others and themselves.

Claiming the right to name oneself is, of course, an age-old issue and practice among feminists; it is but one of many concerns related to women's agency. Notably absent across the discussions of women and mathematics sketched above is any sense of agency. In fact, except for some individual statements (e.g., Ruskai 1995), there seems to be almost no place in the discussion of women, gender, and mathematics given to women's agency or self-determination. Educational and psychological studies have focused on factors that predict success or failure of women in mathematics. Although some of these factors may be related to agency in wider literatures, in studies of women and mathematics, they are con-

ceptualized as variables to be measured by scores on questionnaires and manipulated in the interests of women learning mathematics. Studies of women "in the pipeline" tend to focus on statistics and institutional factors rather than on the women themselves. Although the recent *Beyond Bias and Barriers* report (Committee et al. 2007) is more extensive and progressive in its considerations and recommendations than prior studies, it continues these themes. Without denying the potential value of the changes the report suggests, it is notable that there is no recognition in the report that a campuswide community of women, let alone a department of women's studies, might have a role in improving the position of women in mathematics. Interdisciplinary women's studies has served scholars across many disciplines well, in part because it is a "home away from home" for feminists working to integrate feminist practices and pedagogies into their work with students and in part because feminist theory provides scholars with new lenses through which to view their areas of expertise. The possibility of extending these to mathematics bears exploring.

As noted above, mathematics is barely recognized within feminist science studies or epistemologies. Although serious study of how that might change goes well beyond the scope of this article, it is clear that there are some readily identifiable questions whose consideration might further understanding in this area. For example, in a recent article, Harding argues that for standpoint theorists discussion of the "context of discovery" (2004, 32) is essential. Arguably, the mathematical tools available are a part of this context of discovery. They shape the ways in which data will be coded, analyzed, and reported, and, in turn, the requirements of coding and analysis shape the ways data are conceptualized, gathered, and organized. A full understanding of the context of discovery would seem to require some understanding of these tools as well as the tools used in obtaining data. Karen Barad (2003) has rethought the role of measurement instruments in the physical sciences, arguing that the construction of the instrument is deeply entailed in the scientific phenomena it measures; the choice or invention of a means of measuring is a site for the exercise of agency. While mathematical tools do not fall easily under her discussion, her work inspires thinking about mathematics. Mathematics does include theories of measurement (metric and metrizable spaces), dimensionality, and related phenomena; careful consideration of these in relation to Barad's work might fruitfully relate mathematics to her thinking on agential reality.

In the twentieth century, several philosophers (e.g., Beth and Piaget 1966; Lakatos 1976) linked epistemology and theories of the cognitive development of mathematical ideas. These links suggest that feminist con-

sideration of how children and adults learn mathematics might provide useful insights into a feminist and/or standpoint epistemology of mathematics. Sherry Turkle (1984; Turkle and Papert 1990) comes close to making such links when she examines how computers mediate learning among girls. Several feminist mathematics educators (mathematicians!) have written about the implications of standpoint and other feminist theories for mathematics teaching and learning (Damarin 1995; Walshaw 2001; Anderson 2005). Although their work is largely directed from theory to practice, it might provide a good starting point for thinking about theory.

In conclusion, the time seems right for the development of interdisciplinary women's studies of women, gender, and mathematics. In this article, I have begun to bring feminist constructs and processes to bear on the existing literatures; there are many issues related to women and mathematics that I have not addressed but that could also be studied in this way. While mathematics and women's studies have been remote from, and even alien to, each other in the past, today feminist science studies and standpoint epistemology suggest some clear directions in which theory development might proceed. This reading across several literatures of women and mathematics points clearly to some ways in which women's studies scholars and mathematicians might think and work together in both academic and activist projects.

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