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Empowering Women? Engaging a Technology Grant for Social Change

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Abstract

This paper examines and exposes the writing and implementation of a project, funded by a federal government grant that worked to increase the technological literacy levels of women at an urban working-class university in the Midwest. This three-year study/intervention clearly reveals that disrupting the 'digital divide' for working-class women at our university, particularly women of color, requires engagements with the material and practical realities of their everyday lives. In addition to findings in relation to gender, race, low-income communities and technology, participation in this study/intervention illuminated for the authors--anti-racist, feminist academics and organizers--the consequences and costs of moving epistemological frameworks to acquire the needed resources to fuel our project. Shaping this project to pass in an ideologically 'neutral' landscape rendered us proficient in, and subsequently shaped by, this landscape. In exploring this research path, we name and expose conflicts over institutional 'turf,' the consequences of taking federal resources to pursue our agenda, the failures of the project, alongside the more data-driven findings of the project that relate to gender and technology. We analyze the most 'successful' and unimagined component of this project: the importance of creating spaces where students can participate as legitimate community members (for our population this means in part as paid workers) to learn technological skills without the notable presence of a teacher, a class or curriculum.

Key Words: women and technology, social change, grants

Introduction

This paper discusses what became possible—conceptually, politically, and practically—during the design and the implementation of a project, funded by a US government agency[3], that worked to increase the technological literacy levels of women at an urban working-class university in the Midwest. This three-year project suggests that disrupting the 'digital divide' for working class women at our university, particularly women of color, requires engagements with the material realities of their everyday lives— not merely 'technological infusion' or 'curriculum transformation.' The women at our university with whom we engaged throughout this project needed meaningful employment to sustain academic study. Non-formal educational contexts (no classrooms, no teachers, and no students) became generative sites for them to begin to acquire computer skills and computer expertise (Lave and Wenger 1991; Resnick 1998; Jensen and de Castell 2002).

In addition, participation in this project illuminated the consequences and costs of moving epistemological frameworks to acquire needed resources. Developing and implementing this project shifted us, feminist academics and organizers, from our relatively comfortable epistemological terrain populated by anti-racist feminist theories and praxis, and queer theories and communities, to a landscape inhabited by frameworks of liberal multiculturalism, positivism, a 'politically and ideologically neutral' language of educational reform, and more. Acquiring the needed resources entailed establishing ourselves in this landscape that was seemingly devoid of

familiar intellectual markers or signposts: an analysis of "oppositional theory and practice"[4] and an analysis of "interlocking systems of oppression."[5]

As feminist educators—Erica, Assistant Professor of Education and Women's Studies, and Laurie, Assistant Professor and Coordinator of Women's Studies—our teaching and research focuses on centering marginalized knowledges and practices, and we critique and challenge the dominant social, political and historical production of knowledge. Conceptualizing, writing and working to successfully engage this project pushed us into new terrain and new questions: What are the consequences of a 'take the money and run' strategy for those committed to progressive (often radical) social reform in and outside the academy? How does participation in mainstream discursive and epistemological paradigms shift and constrain us in politically untenable positions? How can we learn from each other to access the resources to fuel progressive social change, yet resist the recuperative power of dominant, multi-faceted institutions and discourses? What subversions are possible given Audre Lorde's powerful pronouncement about power? "*The master's tools will never dismantle the master's house.* They may allow us temporarily to beat him at his own game, but they will never enable us to bring about genuine change" (1984, 112). These questions also exemplify a Women's Studies dilemma; how to work within a system one is trying to change. Women's Studies scholarship and activism encounters these tensions in the academy and beyond, and this theme of feminist change is central in this article and our work.

This paper offers a partial response to the above questions by recounting the intertwined narratives from this project. The first section of this paper offers an initial interpretation: how a gendered (and racialized) problem of technological literacy was identified in a particular context and how two feminist academics worked to acquire resources to shape an intervention. The second section queries this tale by analyzing the consequences of the paradigm shifts encountered to acquire a federal grant. The third section offers a discussion of the findings and observations from this project focused on the technological needs of women in our community and the importance of creating spaces where students can participate as legitimate community members (for our population this means in part as paid workers) to learn without the notable presence of a teacher, a class or a formal curriculum.

The goal of these layered representations is to offer other feminist anti-racist activists within the academy an analysis of the impact, often unanticipated, of the *master's tools* on varied components of a project for social change. In our self-reflexive writing we aim to avoid losing sight of the project itself and becoming "hyperreflexive about epistemology and the politics of knowledge" (Stacey 1999, 689), engaging in what Van Maanen has termed "vanity ethnography." We write as activist-scholars, immodest witnesses (Haraway 1997), committed to radical praxis, who struggle to be careful storytellers.[6]

Part 1: *Show me the money!*

In 1998, we wrote a grant to support our desires for progressive change at our institution. The diverse student body at this working-class urban university includes many students of color, returning adult students, and people who are the first in their families to attend college. The mission—Excellence and Access— is taken very seriously and there are numerous financial and academic programs to aid students who would not otherwise have been able to attend college. For the last six years a national magazine has ranked our university as the most diverse university in the mid-west. In addition, the university is a federally designated Hispanic Serving Institution. In 2002, the enrollment was 10,898 and the undergraduate population (8,101) was composed of 14% African American, 13% Asian, and 28% Hispanic students and 64% women.

Many students arrive at our university lacking basic computer skills: i.e., knowledge about how to use a computer and how to run basic word-processing, web browsing, and email programs. This preparatory deficiency occurs for a variety of reasons: the shortage of computers in public schools, the inability of teachers to adequately infuse technology in high school curriculum, and lack of access to computers at home.[7] Laurie's introductory Women's Studies courses frequently had first generation female university students, fresh from the urban public school system, who had limited knowledge of the use of computers. Her Women's Studies 100 class was web-enhanced[8] and the learning curve for these women was steep, but they were able to acquire practice and experience using technology. In Erica's graduate educational theory classes, returning adult students, predominantly women, entered the university after years out of educational contexts. Their computer skills were often non-existent, and coupled with anxiety about returning to school, they were worried about all the 'new' technological skills that courses assumed they possessed. These teaching experiences indicated that women at our institution, frequently women of color, needed a different kind of access to developing computer literacy.

Fueled by a problem in our local context, we moved from engaging, teaching, and reading cyber-feminist theories and works by transnational anti-racist feminist theorists that questioned the inherent 'good' of technology, [9] to operate within frameworks that constructed technology as an inherent 'good' (or a 'neutral'). Also, we shifted from our general theoretical positionality of questioning the nation-state to developing a project that supported the nation-state through the creation of technologically savvy workers. Although the cyber-feminist literature (in particular the work of Spender 1995, Stone, 1995, Haraway 1991 & 1997, and others) foregrounds this work and enabled us to have important tools to conceptualize this project, this body of scholarship was not able to provide much assistance with writing grant proposals or coping with the day to day realities of the grant, technology and women's lives. Given our focus on material changes for women at our institution we instead found research on the *problem of women and minorities in the science pipeline* more useful for constructing our praxis-oriented project (for example, Hill 1997; van Opstal 2001).

Literature in this area signified what we observed at our institution: women continue to be underrepresented in technology fields, especially in professions that require computer expertise (Hill 1997). The national association, *Advocates for Women in Science, Engineering and Math*, enumerates the following data on the representation of women and people of color in science, mathematics, engineering and technology fields (http://www.awsem.com/gender.asp). Significantly, the data is often represented in ways that separate 'women' and 'people of color' into two discrete groups, for example:

- Only 19% of the science, engineering and technology workforce is female. (*Congressional Commission on the Advancement of Women and Minorities in Science Engineering and Technology Development* 2000)
- By the eighth grade, twice as many boys as girls show an interest in science, engineering and mathematics careers. (*Congressional Commission on the Advancement of Women and Minorities in Science Engineering and Technology Development* 2000)
- The percentage of women graduating with computer science degrees has decreased 25% since 1985. (*The National Science Foundation* 2000)
- Nine percent of engineers are women. (*The National Science Foundation* 2000)

- Hispanics, African Americans and American Indians comprised 22.1% of the population they comprised only 6.5% of the Science, Engineering and Technology workforce. (*Congressional Commission on the Advancement of Women and Minorities in Science Engineering and Technology Development 2000*, 10)
- In science and engineering, black and Hispanic faculty were less likely than white faculty to be full professors, even after adjusting for differences in age; and blacks and Hispanics earned lower salaries than white and Asian scientists and engineers within fields and within broad age categories. (*The National Science Foundation* 2000)

To support the market economy, employees with critical computer and technology expertise are in demand. The Bureau of Labor Statistics reports that the three occupations with the fastest employment growth between 1996 and 2006 are, (1) database administrators, computer-support specialists, and all other computer scientists, (2) computer engineers, (3) systems analysts. The U.S. Department of Labor projects that "new jobs requiring science, engineering, and technical training will increase 51 percent between 1998 and 2008; a growth rate that is roughly four times higher than average job growth nationally" (van Opstal 2001, 54).

Research that framed the absence of people of color and/or white women in science, math, engineering and technology (SMET) as an economic problem for the nation-state was central to our proposal. Schools play a central role in preparing workers for the economic needs of the state. Apple argued in 1979 that the valuing of curriculum that emphasized math and science over poetry and music was not arbitrary, nor based upon the intrinsic higher value of mathematics over music.[10] Rather math and science, "high status knowledge," contributes to the economic success of the nation in ways that music or poetry does not. The absence of a large portion of the population (people of color and white women) in science and technology fields (and science and technology classrooms) poses a significant potential threat for the state to American economic superiority (which we used as a tool to support our proposal).

> As long as S & E [Science and Engineering] workforce is composed disproportionately of white males, its expansion prospects will remain limited. Women and minorities, the fastest growing segments of the workforce, are underrepresented in technical occupations. White males make up 42 percent of the workforce but 68 percent of the S & E workforce. By contrast, white women make up 35 percent of the workforce but only 15 per cent of the S & E workforce, and Hispanics and blacks make up 20 per cent of the workforce but only 3 per cent of the S & E workforce. Efforts to boost participation by these groups in the S & E workforce are the single greatest opportunity to expand the nations' pool of technical talent. (van Opstal 2001, 55)

This threat to 'our' economic dominance pushed government agencies to fund research to identify strategies to recruit and retain these populations in SMET fields.[11] Working with this research and our knowledge of the academic context, we brainstormed ways of interrupting our students' educational trajectory to give them a different kind of exposure to technology. The research suggested that in the areas of math, science, and technology, women learn better in a single sex environment[12] and where relationships are involved, as in cooperative learning groups (Allen 1999; Streitmatter 1999; Felder, et al. 1995; Koch 1994; Clingingsmith 1993; Matyas and

Skidmore 1992; Tobias 1990). In addition, we realized that the enabling technological experiences needed to occur early in the students' academic career. If, in the first year of college, students opt not to continue in SMET fields, it becomes increasingly difficult to return and graduate with degrees in those fields (Allen 1999; Tobias 1990). We also considered that a component of project might be technology infusion—not to teach technology directly—but to infuse the instruction through other content.

With an idea in place supported by research data and our observations, funds were needed to support these visions of change. Several governmental agencies that funded educational reform had programs targeting under-representation of 'women and minorities' in SMET fields. We spent months working on our proposal. We sought out and received comments from outside reviewers and editors. We organized a budget and worked with the grants office at our institution to complete the application package. We worked to align ourselves with the discourse of the request for proposals (RFP) and, fortuitously, the American Association of University Women published a report that stated "technology was the new boys club," and we hooked our grant proposal onto their research findings (AAUW 1998). We wrote 15 pages that articulated a seamless vision of an intervention that would facilitate institutional change. "**AN AGENDA FOR EDUCATIONAL CHANGE: EMPOWERING WOMEN FOR LIFE-LONG SUCCESS THROUGH COMPUTER EXPERTISE."**

> The Project Investigator (PI), assisted by an interdisciplinary advisory board, will design and implement an Empowering Women section of an already existing first year course, the University Seminar, a course that introduces students to college and teaches skills and success strategies. ... This Empowering Women section will be for women only and will use cooperative learning groups and life-like problems to develop critical thinking. ... In addition, we will set-up a small open access single-sexed computer lab. This lab will provide peer-mentoring to encourage more women to master technology in a comfortable and supportive environment. The lab will also be available and open for other women in the university community who need computer learning support. Female peer-mentors, to nurture computer expertise, critical thinking, and cooperative learning, will staff this lab.

Our project was funded for four years, and the consequences of passing in this genre surfaced throughout the project. We thought that if the grant was acquired, we would be able to return to our context and work with our familiar feminist toolkit and proceed with our project unscathed.

Part 2: Passing in a brave new world?

Based on the language of the official RFP (and the accompanying resource booklet and telephone calls to the program officer) it was clear that successful proposals originated from a positivistic and a (mythic) politically neutral epistemological terrain. Our proposal used language seemingly representative of this paradigm (empowerment, life-long learning, assessment and evaluation, curricular transformation, quantitative data gathering) rather than terms that signified any allegiance to discourses of post-structuralism, feminism, or critical (race) theory. We did not include our ideas about dismantling (or even questioning the neutrality or the assumed inherent good of) the nation-state or educating women to resist white-supremacist capitalist patriarchy, but instead wrote a request for money to help women join in the economy. Shaping our proposal to pass in this ideologically neutral landscape rendered us proficient in,

and subsequently shaped by, this landscape. Passing in this paradigm isolated us and the project from the familiar critiques and comforts of our everyday landscape: languages of justice and anti-racism. The specific language needed for the proposal constrained our thinking, our imaginations, our actions and our responsibility. As a result of the limited discursive and epistemological moves we could make while tethered to this paradigm, tensions unfolded. This section offers examples of the consequences of engaging with positivism, of animating particular epistemological paradigms through the use of signifying words/phrases, and the consequences of circulating in a paradigm that lacks the theoretical tools that had historically enabled us to work against the "legitimacy of the dominant order" in the first place (Lather 1991, xv).

Language is one way participation in particular epistemological paradigms is signified. Language also signifies to audiences 'where' (often ideologically) to place work.[13] Working in a landscape devoid of the tools that typically enabled us to move toward progressive social change was visible in the design of the project. We worked hard to eliminate any language that would be perceived as subjective or postmodern (dialogues, discussions of power imbalances between students/subjects and professor/principal investigator, reciprocity, etc.) or political (the words feminist, white supremacy, and more). This discursive paradigm tightly framed possibilities for intervention and what we could officially document when the program concluded. For example, when the data collection process started, the questions to the participants were shaped by the language of the grant's request for *replicable reform strategies* and *quantifiable results.*

We chose language that would legitimize our project, yet this left us unsatisfied. A word that quickly became a stumbling block was *minorities*, a term that we would not use in our teaching, academic, or activist writing. Our preference, given the connotations of the term *minorities*—less than (whites) in importance and also less than (whites) in numbers—was *people of color* or *women of color*, yet the call for proposals used the term *minorities*. The phrase *women and minorities*, signifies that women cannot be minorities and minorities cannot be women, also appeared in the RFP and in most of the research on the 'problem of women and minorities' in SMET. When we gave a draft our the proposal to a friend, a physicist who had received many grants for educational change, he said "the *of color* has to go. Use *minorities.* They will not know what *of color* means." We thought about using *people of color* but decided that non-conformity with no money wasn't productive.[14] The word 'empower' was chosen because of its perceived appeal to the granting agency. There is significant work in feminist pedagogy and methodology critiquing the notion that researchers can empower subjects/participants (Patai and Gluck 1991) or that teachers can empower students (Ellsworth 1989), given the power dynamics between researcher and subject and between teacher and student in a classroom. We did not know if this critique of and sensitivity to the term *empower* was shared by government funding agencies. We suspected it was not, therefore we chose to use *empower* and *minorities* thinking the use of these terms might make our project more legitimate in their eyes.

What are the consequences of writing in a different genre, with different norms and vocabulary, in order to access institutional resources? Professionals often code-switch or use a variety of social languages many times in one day (Wertsch 1991). Why should the use of terms such as minorities or empower constrain us? Superficially, using the discourse of grants means we must attend conferences and be identified with a project called *empowering women*, a name that makes both of us wince.[15] At a deeper level, our adoption of this discourse also engaged with an epistemological system. Language is not neutral; language shapes ways of thinking about ourselves and the world we inhabit (Bulter 1996; Walker 1998). Using the granting agency's

language validates an epistemological framework of multiculturalism that is, at best, problematic (i.e. McCarthy and Crichlow 1993) and this has the capacity to literally produce subjects and create realities.

The paradigm we languaged ourselves into was not able to support the kinds of radical institutional changes we desired. We envisioned the grant with social change as the goal, not as to increase and diversify the labor market, yet to get the money we wrote and performed the latter. Our idea was that women participants would knowingly use their skills to enter the labor market and support the white supremacist capitalist patriarchy. Somewhere along the way (as we will contextualize in the last section) our steadfast critique of producing labor for the nation-state was reframed.

Months after the award was announced *The Chronicle of Higher Education* had commentary on the recent government agency's awardees (Brainard 1999, A59-60). The article had perspectives from the agency's acting director, from the Deputy Assistant Secretary for Policy, Planning and Innovation, and from a policy institute member on the recent allocation of federal dollars towards educational change. The author argued that many were not satisfied with grantee selections. Abigail Thernstrom, a senior fellow at the Manhattan Institute in New York, took issue with projects that focused on minority groups—or "under-represented" students—which made up 9 of this year's 26 grants (A 60). Her critique was that this agency targeted federal monies specifically to focus on under-represented groups. She stated,

> Obviously, there's a real problem in terms of the racial gap in academic achievement, and I'm very sympathetic to addressing that problem, but I want to address it through race-neutral means."… [E]ven if one accepted the need for such efforts, she said, she took issue with "one such … grant awarded this year. It will finance an effort at [our university] that would focus in part on helping minority women develop computer skills. (Thernstrom, as in Brainard, A 60)

Not only did Thernstrom call for "race neutral" educational change she mentioned our project specifically as problematic since we were focusing on women of color and technology.

"Race neutral" educational change is not feasible, and as research has demonstrated it is not effective. Eisenhardt and Finkel (1998) found that race and gender neutral environments in the sciences are only neutral to the white males that construct that environment. From our point of view "race neutral" is a code word for supporting white supremacy. Those committed to social justice, both inside and outside the academy, need to be able to decode the various ways that language is used to cloak, shape, and frame regressive political initiatives: i.e., the 'new' Racial Privacy Initiative.[16] These dominant oppressive "technologies" of language function to "colonize the consciousness" (Sandoval 2000).[17] In addition, questioning the choice to fund projects focused on people of color and/or women is connected to charges of 'reverse discrimination' and to larger critiques of affirmative action (Guinier 2003, McCarthy and Crichlow 1993).

We were used to organizing against this *dominant order* from within our feminist, post structural paradigm, yet our code switching abilities were seriously hampered and we were unable to access the critiques of power and knowledge in order to name Thernstrom's position ideologically. We found ourselves in the position of defending *our* articulated strategies of change (framed by our funding agency), with a discourse that was wholly inadequate to critique the mythic "race-neutral" educational change and to deconstruct the larger critiques of

affirmative action that Thernstrom animated. She singled out our project (and consequently our university) because our educational intervention was not race neutral and thus problematic to her. Our university is not often mentioned in the *Chronicle* and here our project (and university) was featured negatively. Someone from the university needed to respond, yet our location within the university hierarchy, as untenured faculty, framed our reply. Given this context, in our letter to the editor of the *Chronicle*, we wrote that we ***disagreed*** with Thernstrom's position, because "Race and gender are pivotal aspect of our lives that cannot be rendered invisible. Our project to empower women for life long success is one way of trying to solve the inequities of our educational systems" (*Chronicle of Higher Education*, 10/8/99). Not able to follow Sandoval's (2000) suggestions to embrace mobility and to implement tools across paradigms—the 'we disagree' statement that we wrote in response was not adequate, not enough, to combat the powerfully convincing rhetoric advocating race neutral strategies.

This desire for a "neutral ideology" also impacted our project through the granting agency's request to add language to ensure that the project would not discriminate against anyone. (To note of course is that the requirement for non-discrimination comes from the critical work of earlier paradigm-changers.) The government doesn't fund anything that discriminates against any group. We added special language to our proposal before it was accepted, specifying that this project would not discriminate against any group of people. The 'women only' project could not be advertised as for 'women only,' even though the proposal specifically articulates that the study/intervention was to create a single sex classroom environment for women. The brochures for the program used language like "specifically designed for women," and "targeted for women."[18]

The positivist language of the grant had led us to a very strange place: our project had now required us to defend language and paradigms we previously critiqued, to promise replicable products (when we didn't think curriculum was portable or worked decontextualized), to prepare and promote workforce development for the nation-state, and to advertise "Life Long Success Through Computer Expertise." Finally, we agreed not to discriminate in our discriminatory project.

Part 3: The real thing: endings, beginnings, and findings

Our proposal was written to acquire resources to support change on our campus. We focused more on the writing process than on building networks and understanding university politics, as it was relatively inconceivable that our proposal would be funded.[19] Our nascent set of university networks and vague understanding of university politics, factors essential to run a 'successful' project, led to unexpected outcomes. This section addresses what became possible, often unimagined, from the "Empowering Women for Life Long Success Through Computer Expertise Grant."

At the proposal writing stage we consulted briefly with the director of the University Seminar Program and the Dean of Academic Development (his boss) about our project and about future collaborations. In these preliminary discussions, it wasn't entirely clear to us or to the director what our expectations of his department would be. After acquiring funding, we were in the awkward position of 'telling' the faculty and staff who organized and taught the course that we would create a new technology-infused curriculum for them to adopt. However, the director needed time to understand the changes we had proposed. He didn't know what web-enhanced might mean and was justifiably nervous about committing faculty to something they might not be able to do. This was the first lesson we learned about campus organizing: Even though folks

may think something is a useful and interesting project, they don't want changes imposed from outside. Either they need to be a major participant in the writing process or they will legitimately drag their feet during implementation. However, we worked successfully with the director and other faculty and the first section of this course was offered in the fall 2000 with two-more sections taught in fall 2001. Over the summer 2002 technology training seminars were held for faculty who regularly taught this class and a generic course website was created for all faculty and students to utilize by fall 2002.

While this course was successfully redesigned, many of our visions for curriculum development and student and faculty transformation were unattainable. Not only had we established inadequate groundwork with the faculty who taught the course, but we chose a class to transform (University Seminar) that had enrollment problems. The University Seminar does not count toward general education, nor does it count toward any major or minor. At our university, most students are the first in their families to attend college and they work at least part time to support school. Courses need to ***count*** for something. As our project progressed, we discussed working with university committee structures in order to get the course to count as a general education option. Unfortunately, as the University Seminar focuses on college success skills with no disciplinary content, faculty view the class as remedial.[20] Although this course teaches skills that enable students to succeed in college (reducing degree completion time), it cannot be used towards a major, minor or a general education credit, and therefore it frequently suffers from low enrollment.

Our project's focus on women added to the enrollment problems. Given the research on women's successes learning technology in single-sex environments, coupled with our own background and familiarity in Women's Studies environments, we did not envision that the single-sex aspect of the course would be a problem. The brochure advertising the course had photos of women, used the language—"specifically designed for women"—cited data about the state's need for technology workers, and listed employment opportunities in technology fields.[21] Interviews with women who enrolled in the women-only sections demonstrated that they had selected this class not because it was women only—but because of the technology and the statistics cited on the brochure in relation to job opportunities. Interviews further illustrated that many of the female students in fact thought about NOT taking the class because it was women only and they had to defend to family and friends why they wanted to take a course *for women only*.[22] Enrollment was a continual problem due to the University Seminar status and because it was offered for women only.

Another aspect of our project that we were under-prepared for was faculty/teacher transformation. We expected that faculty, when introduced to different, possibly more effective teaching methods through the integration of technology, would want at least to experiment and (hopefully) work to transform their curriculum. This was not the case. At a working-class institution, while there is a push to incorporate technology into classrooms, there is not adequate support for these initiatives. Faculty, already asked to do state mandated assessment and wary of a fad that will mean more work and no recognition or remuneration, were hesitant to start a new project. Additionally, faculty teaching University Seminar were comfortable with the pedagogical (and for some technological) methods they already used and/or had developed. They were interested in the technology but not completely convinced of its importance or need within the context of the class.

As the project draws to a close, aspects of how women use technology on our campus have changed. The technology-infused curriculum did have an impact on the technological

literacy levels of students. Surveys, interviews, and participant observation demonstrated that first-year students, women (and later men in campus-wide sections in fall 2002) who took a University Seminar course that had been redesigned and had technology infused into the curriculum (as of 2002 more than eighty students and increasing) had little to no technological expertise at the start of the class. For example in our first "Empowering Women" class, fall of 2000, only two out of twelve students had computers at home and only one used the computer daily or had a computer in her room. Three out of twelve had used forms of electronic communication prior to the class. All enrolled in this course because they thought they would need to 'know computers' in order to get a good job. Before they took the course, all the students stated that they would not register for a course that was listed in the university course catalog as web-enhanced or required the use of the World Wide Web to relate to the professor or the curriculum and many students stated that they were "afraid" of technology or "dumb" about it. None of the students could make a webpage. By the end of that first semester, all students could use email, could make webpages (using Netscape Composer and other programs), navigate the web, use Excel, and when interviewed, stated that they would consider taking a web-enhanced class or a distance education class. Clearly, their proficiency and confidence levels increased. This finding was repeated in year two of the project, and in year three the curricular changes we developed were implemented throughout most of the sections of the University Seminar[23]

Our proposal implied that curricular transformation would be the location of change, however empowerment did not come from curricular or faculty transformation, instead it resulted from peer tutoring and informal workshops. The importance of creating spaces where students can participate as legitimate community members (for our population this means in part as paid workers) to learn without the notable presence of a teacher, a class or curriculum was an unanticipated result of this project. The grant funded a computer lab with 5 machines, a phone, a printer and peer mentors/lab assistants to assist and teach students technology. The lab is located next to the Women's Studies department and there are sofas and coffee tables in a small common area outside the lab. The first group of assistants hired in 2000, were three Latinas and one returning adult white woman. They decorated the lab with posters from the Women's Studies Program and named all the computers after famous women scientists. They used the lab as a site for their own work, socializing, and organizing (usually after working hours). Their job was to staff the lab and teach other students—help them learn to email, use spreadsheets, create web pages, etc. They placed signs across the campus, made business cards that they delivered to classes (first to Women's Studies classes/faculty and then expanded to other courses) to let students (and faculty) know that one-on-one help was available.[24] Fifteen women have worked part-time over the four years as lab assistants.[25] Four had limited technical experiences and only needed a small amount of technical training to start work, while the other eleven who had little to no computer experience, were trained on the job by other lab assistants and by us. Students from Women's Studies, Psychology, Education, Business, and other departments utilized the lab.[26] Over the past two years more than twelve students per week came to the small lab for assistance. The huge open labs on campus have roughly 350 computers available and most are in use from 10am-7pm Monday through Thursday. That is approximately 350 students using computers 9 hours a day, 4 days a week, or something like 1260 students. Thus we think that 12 students per week (about 10% of the computer using population) receiving one-on-one assistance is an accomplishment.

The assistants work with a range of technological and often academic problems and a variety of students: the 80 year old woman who audits courses and immediately forgets what she

learned at the last tutoring session; students who are recent immigrants from Mexico who left villages with no electricity; young women who finish college and need help with their resume and job searches to get a first full time job; students who do not have a computer at home and did not use a computer in their high school classes and need help learning the skills to complete a specific assignment. The lab assistants' work also transformed their own ideas about what they can do:

> Lilly, *19 year-old Latina*[27]: Before working in the Empowering Women Computer Lab, I had no experience with technology. In fact I had very strong feelings towards computers. I hated and feared them. Every time I had to use a computer I would try my best to avoid it. ... I know I'm not the only woman that has ever felt that way about technology. ... In [a class that taught technology] I not only overcame my fear towards computers but I became inspired to share this experience with other women. Shortly after my first semester I began working in the Empowering Women Computer lab. I learned how to use "Microsoft Word," "Excel" and other computer programs. I also learned how to make web pages. Now when women come to the lab I can teach them everything I've learned. It is a great feeling to be able to share my story with other women and to know that I have encouraged them to approach computers and many other new territories without fear. At times after doing some work with the women I would have intimate conversations with them. Their stories remind me of the importance of what I do and how much more I can do. (Interview, spring 2002)

> Marg, *55-year old white woman*: When I was asked to work in the lab I was honored that someone else out there knew my passion and focus on empowering women. I thought I really knew everything about computers, boy was I wrong. Not only did I educate women but I also educated myself at the same time ... I love to help people especially women. Not only to bring out their inner knowledge but also share some new ones as well. Also to show them what they do have to offer to the world. Too many women feel that they do not have anything to offer, not enough, scared, intimidated or that no one cares. Unfortunately many times that is still true. The job of the lab and the assistants is to empower these women not to be afraid to explore their knowledge. (Interview, spring 2002)

The assistants' jobs require that they practice the technological skills they acquire and they become innovative technological and academic trouble-shooters. From observations and interviews, it is clear that lab assistants learned from teaching: they increased their own skill levels, became better able to navigate the university and academic context, improved their writing skills, and increased their confidence levels. The majority of the women we hire to be lab assistants are first generation university students that support themselves (and often their families) with loans, scholarships and part-time employment. They are representative of the larger undergraduate population at our university. Typically, the part-time employment these lab assistants had prior to working in our lab was low-wage service industry jobs. For example, Lilly worked as a telemarketer and as a fast food cashier and while this labor enabled her to support herself and her daughter (with some assistance from her family), these jobs did not enhance her resume, nor did they support or coincide with her academic and professional goals (to work in

the law-enforcement field). The paid employment that women did prior to working in the lab (waiter, telemarketing, service sales, child-care and fast-food cashier) was feminized non-union service-sector work. At the lab, the assistants were the experts, they had knowledge and skills that others wanted, and they worked in these "expertise" positions in cross-generational and cross-racial contexts. A part of their job was to engage in professional development and this entailed developing new skills. Thus, the assistants' view of themselves changed.

> Lilly: If someone comes in with a technology question, like how to find a webpage or use a program, I just sit down with them and I show them and then watch them try. I learn new things when they make mistakes too… Sometimes I am worried that I will not know what they need but when this has happened Laurie can come over and I get to see, like the time we were working out the FTP problem… They [lab user] are usually really relieved and happy when something is solved or made clear. I never thought I could do this. I mean I probably could have but I don't know where I would have learned. (Interview 2002)

They articulated feeling *empowered* by their skills and their success. Their boss and the people they assisted took them seriously as skilled human beings. They referred to their work as "teaching", or "working in the lab" and this gave them a meaningful campus and employment identity.

The material contexts these women face in their lives, how to support themselves and/or their family on low-wages, is a critical factor that shapes their academic trajectory. When roles as 'worker' and 'student' conflict, as is the case for many of our students who swell the ranks of the low-wage service industry sector, the material realities—paying rent, supplying food, and even covering tuition—surpass paying attention in classes. The lab assistants managed to avoid some of this role conflict, as their paid employment connected to their education. They worked in the same physical spaces that they studied and their identities as 'worker' overlapped with their identity as 'student.' Additionally, they received above the minimum wage for paid work on campus (and above federal minimum wage)[28]. For the lab assistants their on-campus employment provided a connection to a community that included: the other lab assistants, Laurie as their boss, and the students who counted on them for their expertise. They came to understand their value in a (feminist) community of learners and they possessed a physical space they considered their own, the lab, their office, their location at the university. As Rose, a 22-year old Latina stated: "It was a home for me. It was like my office and my place on campus. I could do work there in the downtime. And there was always someone for me to talk with if I needed it. It made me know if I came to the university there was a place for me" (interview, 2002).

The lab also became a site for student organizing. In 2001-2002 a lab assistant was also the organizer of the Gay Lesbian Bisexual Alliance (GLBA) on campus and another was the organizer of the Feminist Majority Leadership Alliance (FMLA). These student clubs used the lab to create promotional materials for events, to electronically communicate with members of the group, and to do research projects together. [29] The lab space was routinely full of books, posters, notes about campus and community events, pamphlets, left-over food from student events, and assignments that lab participants (or assistants) were working on. FMLA and GLBA members also taught each other technology, especially the various means of electronic communication. The lab assistants created or helped to create posters, websites, bulletin boards and listservs for both groups. "I learned skills because we would be taking about doing

something, like communicate an issue, the vote drive, and the computers were always there. We always know we can ask Laurie for help but we could also figure it out ourselves" (Marg, interview 2002). Because of the proximity to the Women's Studies department and the availability of the sofas outside the lab, it was also a hangout for students. Students would organize meetings or leave messages to connect socially "at the lab". The floor the lab was located on during its first two years also housed the faculty and staff of the international program, the women's services and returning adult program (our campus women's center), the honors program and the non-traditional degree program. The location provided the lab assistants with access to vital information. Most of the lab assistants utilized the resources on the floor. They joined the honors program, went on an international trips, completed their degrees earlier by graduating with non-traditional degrees and used their knowledge to help their on-campus communities (the queers, student of color, feminists, and socialists) do the same. "I always know there will be something happening in the lab. At least one person I know will be there talking about a class or a professor or a good story about somebody. You just get connected" (Lilly, interview 2002). Interestingly, now that the lab has moved from a student services floor to floor comprised of mainly faculty offices and classrooms, the lab attracts more non-targeted, drop-in, students and the space facilitates interactions between students and the faculty.

The success of the lab component to teach students at our institution, in particular working class women of color, a relationship to technology, is not startling. Meaningful work experience, mentoring, community development, and peer learning facilitate academic growth and the acquisition of technological skills. Learning or legitimate peripheral participation in communities of practice, "is a process that takes place in a participation framework, not in an individual mind" (Hanks, in Lave and Wenger, 1991, 15). There was no formal curriculum, no teacher and no classroom structure, yet the lab assistants, their peers, and the social communities they were a part of learned technology. The two student groups (FMLA and GLBA) used technology as a tool to organize and create relationships; students wanted to work together to make webpages for the FMLA or the GBLA. They used technology as a tool for community building and advancing social and political practices they were invested in. The importance of non-formal educational sites in the acquisition of technological skills/expertise is supported by Michael Resnick, one of the instigators of the "computer clubhouses,' community spaces that are set up to get youth involved in technology (at present there are 50 sites funded by INTEL). Resnick argues that "access [to computers and technology] is not enough, access is just a starting point" (in Marriott 2002) in closing the digital divide, and that fluency with technology is what is needed.[30] The computer clubhouses, informal spaces that use mentors (artists and professionals) not teachers, facilitate not just access but mastery.

In conclusions

There is no neat and happy ending to this story. Curriculum transformation did, in our context, enable female students who completed the course to attain a higher level of confidence and technological abilities. The meaningful (and paid) apprenticeship of the lab assistants during the same time period enabled them to acquire a wider range of skills and most importantly, a kind of fluency that was not evident in observations, interviews, and assessments of coursework done by the students who only took the technology infused University Seminar course. Faculty did integrate technology into their classes and all faculty made use of the generic course website we created. Our project helped us create a relationship with the director of the University Seminar and to understand the importance of the academic development community on campus,

both valuable experiences and that might have been inaccessible without this project. While acquiring the resources to support this change was significant, negotiating how language and epistemological frameworks shape and constrain projects and political action also has been a valuable 'finding.'

Our initial overwhelm of being constrained by the language of the grant, the *Chronicle* article, our response, and our conference presentations based on the grant writing began to dissipate as we became immersed in the project. Laurie's teaching of the courses and mentoring of the lab assistants grounded her in the materials aspect of the students' lives, work, school, family, etc. Erica's in-depth interviews with the same population refocused the project on the students' needs and outcomes. This brought us back to our initial goals—social change for women at our institution.

Our project complicates arguments that advocate for women-only learning environments. While our project does not dispute the fact that women's educational choices are constrained by compulsory heteronormativity (i.e. women in Empowering Women University Seminar stated that women-only learning environments were 'unnatural' thus clearly negatively impacting their educational choices), we had a difficult time recruiting women to participate in a women-only course. Low enrollment does not mean that students wouldn't benefit from participating in the course, yet women at our institution expressed reluctance to take a women-only course. This presents a problem. Even if we think this is the best educational environment, if no students enroll, despite creative marketing strategies, it is not an effective educational intervention, nor is it the 'best' environment. In addition, most of the literature that looks at the efficacy of women-only learning environments does not adequately address how race and class impact single-sex learning environments. The multi-racial, working-class population that attends our university calls into question single-sex learning environments that do not take into account race and class.

For us, the structuring environment was not the single-sex classroom, but the constraints of the students' lives and their need for meaningful employment, in addition to their need for the technology skills. Consequently, we tried to create opportunities for employment and skill development. We began to question what it means to work within the discourse of the nation-state that desires the production of "good" workers. We started this grant questioning this goal and viewing our work as 'feminist' educators not to merely assist in the shaping of compliant subjects for this economic order, however, what became clear, quickly, was that the women we wrote the grant for needed employment. Not just any thing that would put money in their pockets but *meaningful* employment, employment that empowered them in their lives. While our academic trajectory to this point had continually positioned us to critique the goals of the nation state and the economic order – participation in this project has illustrated to us the need to be both critical of the nation state, yet work to create employment opportunities that simultaneously "maintain" it. The feminist, activist, and geographer Ruth Gilmore, writing against the mass incarceration movement, also argues against static notions of power and resistance. "One works with what is at hand; the problem is not the "master's tools" (Lorde 1984, 110) but the effective control of those 'tools'" (23).

The feminist work becomes layered – how do we change the paradigm that constructs educational equity as *a good* when it is contextualized within the preparation of a workforce? How do we alter this paradigm when it is the very paradigm that makes *us* (women and technology) visible within the eyes of the nation-state? How can modes of resistance be enacted and conceptualized, from within the master's house? Sandoval, working from Foucault, states:

> Citizen-subjects who are interested in generating effective modes of resistance capable of confronting neocolonial postmodernism must first recognize the fact that much of our perceptual apparatuses and tactics for action are based on past, outmoded yet residual conceptions of power and resistance. (162)

We began the project because we believed (and still do) that it is imperative that students, especially women of color, be given the opportunity to develop computer expertise in their college classes. We end the project with the knowledge that we were naive to hope to be able to 'take the money and run' yet this process enabled us to gain perspective on the importance of implementing (and theorizing) educational and institutional change.

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[3] In order to ensure anonymity for our participants (whose names have been changed in this document) we do not name the funding agency.

[4] Lather (1991) defines oppositional as “those discourses/practices seeking to challenge the legitimacy of the dominant order and break its hold over social life” (xv).

[5] The Combahee River Collective is credited with coining this phrase in 1977.

[6] “We” is an artificial entity constructed for this paper. Throughout this process the two authors, committed to similar desires for progressive social change and inhabiting similar feminist anti-racist epistemological terrains, have held different positions in relation to this project and to the institution. These differences are written out of this version, not to create a sense of seamless unity, rather to create a coherent story.

[7] The 2000 Report “Falling Through the Net: Toward Digital Inclusion” (National Telecommunications and Information Administration) stated that, while gains were being made, there was a significant racial gap in access to personal computers and the Internet at home. The report states that approximately 1/3 of the total US population uses the Internet at home, only 18.9% of African-Americans and 16.1% of Hispanics use the Internet at home.

[8] The class meets ‘face-to-face’ but is also augmented through online components including writing conferences for group work.

[9] Transnational feminist scholarship illustrates that the material lives of poor women of color who construct personal computers are not ***progressively*** impacted by technology (Mohanty 1997).

[10] For example science, math, and technology high school teachers typically receive high pay than art and music teachers and the disciplines of science, math, and technology are viewed as the “most important curricular knowledge” and “given large doses of federal support to assist its adoption in schools” (Apple 1991, 37) while art and music education, frequently feminized teaching practices in schools, are often defined as extra-curricular.

[11] For example, the 1991 American Association of University Women (AAUW) report, S*hortchanging Girls, Shortchanging America*, followed the same tenor of *The Nation At Risk* (the educational document issued in 1983 under the Reagan administration). A clear theme in the AAUW report is that since the jobs of the future require math and science, where will our nation be if girls, 50% of the workforce, cannot do math? This is also a theme in the 2000 report: *Congressional Commission on the Advancement of Women and Minorities in Science Engineering and Technology Development:* "Land of Plenty.” Problematically, both of these documents do not focus enough on how the epistemological, disciplinary and professional boundaries and practices of SMET ‘discriminate’ against people of color and/or white women/girls.

[12] In 1998 the AAUW Educational Foundation released an inclusive report, *Separated by Sex: A Critical Look at Single-Sex Education for Girls*, summarizing current research on single-sex education. This report found that single sex education does not have benefits once adjustments were made for differences in students’ socioeconomic status, pre-enrollment ability, selectivity of the school, and other variables.

[13] This may seem trivial, *being able to signify one’s political position*, but if “Language is delimitation, a strategic limitation of possible meanings” (Lather 1991, xix) then certain positions are made possible and others impossible through language. We rendered our most useful tools, our allegiances, and ourselves invisible.

[14] In retrospect, it would have been useful to use the term people of color and to name why this was important in a footnote *(The Land of Plenty* Report does this). We wanted to get the grant and not have our proposal appear to be condescending, be interpreted as a lesson to the reader, or (most problematically) be dismissed as not relevant.

[15] The word empowering is relevant and appropriate in other contexts. For example the grassroots non-profit organization Beyondmedia (http://www.beyondmedia.org) uses the word to describe the workshops they do on media activism with under-served and under-represented women and youth. They give the participants the skills they need to tell their stories, articulate their identities, and organize for social justice through the collaborative creation and distribution of alternative media arts.

[16]The Racial Privacy Initiative would prohibit collecting any ‘racial’ data by public institutions (with a few exemptions) under the guise of ‘privacy.’ Of course unstated in this initiative is that this data often illuminates the

"undisputed racial and ethnic disparities in every realm of American life" as Williams writes. Who will the 'non-collection' of this data benefit (Williams 2002)?

[17] One example of the ways this "neutral" language has been used to create movements against affirmative action in the United States is California's proposition 209 that passed in 1996. *"The state shall not discriminate against, or grant preferential treatment to, any individual or group on the basis of race, sex, color, ethnicity, or national origin in the operation of public employment, public education, or public contracting"* (California Secretary of State 2002).

[18] The brochures also used statistics from the Bureau of Labor highlighting the growth in technology related fields of employment. We advertised to the desire for jobs and lucrative employment.

[19] Given the number of proposals the granting agency received the odds of getting funded were 5%.

[20] A significant question that arose from this process was what counts as "real" academic course work at a university focused on open access? Students can attend our university through a variety of special programs that assist those not able to access the university in more traditional ways. It is troubling how some colleagues focus on rigor or the inherent quality and standards of a discipline thus disparaging the unique opportunities of teaching at our university. Simultaneously not creating an environment where all students are enabled to be successful in college.

[21] Although critical of those calls for more technology savvy students, we recognized many students attend college in order to learn skills and attain "good" jobs. Our brochure appealed to those aspirations.

[22] From the interviews it is clear that these women (and their family and friends) were troubled by the idea that they were doing something un-natural by taking a single sex class. The students had to convince their friends and family that a women-only environment was 'okay' because it was about becoming better prepared for the job market. The conception of the all women environment as 'un-natural' or 'not normal' 'not regular' arose in the interviews, an example of the ways interlocking forms of oppression manifest. There was a gap between 'our' (lesbian, feminist, academic) understandings of the utility of a single sex environment and how we can meaningfully translate this to students in our context. Misogyny and more centrally homophobia (Pharr 1997) function as discrete but powerful barriers to discourage women from taking a women only class and we were limited in our ability to address these issues, partially due to the subject matter of the seminar.

[23]The project involved collecting pre/post data (surveys and interviews) from our Empowering Women University Seminar classes and collecting pre/post data (surveys and interviews) from university seminar courses that ran concurrently and were not technology infused. Our project coincided with the university's move to support and promote the use of Blackboard.

[24] The general open access student computer labs on campus are not staffed with assistants to help students learn. If staff are not busy or required to stay at a central desk they might assist students in a dire emergency, but their job is not to facilitate learning or to teach.

[25] At the end of 2003, the institution will absorb the lab. The lab will continue to exist but will be funded by the university, not through an external grant. We are negotiating to retain the ability to hire the assistants and to oversee the lab, but the name will be changed to be more inclusive; it will be the "Empowering Students Computer Lab."

[26] By the end of year three we had at least 20 faculty members who regularly directed students to seek assistance at our lab (data generated by referral information and online survey filled out when entering the lab).

[27] The names have been changed to protect students' anonymity.

[28] This higher wage was achieved because we argued that those working in technology fields 'merited' higher wages because of market competition.

[29] The proximity of the lab to the Women's Studies Office perhaps provided a sense safety and legitimacy to these projects

[30]All the photos in this *New York Times* article—4 large color pictures— are all of young men (of color) engaging with technology and the article does not cite any young women that participate in the project. The article does cite a female staff member of the project (Marriott 2002).

Gender, Context, and Physics Assessment

By Laura McCullough

Abstract

A persistent gender gap exists on one of the most commonly-used physics conceptual tests, the Force Concept Inventory. The test includes many stereotypically male contexts such as hockey, rockets, and cannonballs. A revised version of the test was created using stereotypically female contexts and both versions were randomly administered to 300 college students. While the total correct score did not change for men and women, significant results were discovered when test questions were examined individually. Results suggest that context can affect performance on a physics assessment for both men and women. One implication for instructors is that they should be aware of how their examples and problems can elicit different performance among women and men.

Key Words: science education, assessment, context

Introduction

Issues of gender inequality and science have been under discussion for many years. Despite ongoing concern on the subject, the physical sciences remain heavily male-dominated, with physics demonstrating one of the most severe under-representation of women (NSF 2002). In an increasingly scientific and technological world, society needs to encourage all people to learn and study science and technology. To make educated choices about public officials and politics, and to make the best choices about their health and well-being, people need to understand the basics of science. In general, we are not doing a good job with our women and girls. Women fear or are feared by the culture of science and in consequence are not getting an adequate scientific education, which in turn means that they are not always in a position to make the most informed choices for themselves and their families. It follows that actions to specifically enhance learning for women need to be taken, as well as actions to encourage women to seek careers in these fields.

In the United States women do well in education at a general level. They earn 57% of all bachelor's degrees and 44% of doctorates. Yet in the sciences those numbers drop dramatically, particularly in the physical sciences and engineering.

In physics, about 50% of high school physics students are young women (Ivie & Stowe, 2000). This is encouraging, although the advanced placement courses are still more heavily populated by men. But at the college level only 22% of physics bachelors degrees are earned by women. That number drops further to 14% at the doctoral level. The statistics for participation in physics and other fields in the U.S. are available from the National Science Foundation (2002).

Teachers of physics also illustrate this gender discrepancy; at the high school level, only 29% of physics teachers are women (Neuschatz & McFarling, 2003). In college, women make up only 11% of assistant professors, 10% of associate professors, and 5% of full professors of physics (Nelson & Rogers, 2004). This means that young women have few role models and female mentors available in physics.

Across the world, the percentage of women in physics is not much better (Ivie, Czujko, & Stowe, 2001). France has one of the highest levels, with 27% of physics PhDs going to women. Many Asian nations are lower in ranking, with China at 13% and Japan at 8% of PhDs in physics going to women. This is a worldwide problem, and all countries need to focus on promoting the participation of women in science.

Why is there such a strong gender disparity in physics? Part of the answer lies with physics education. Poor pedagogy is a large factor in students' decisions to leave science (Seymour & Hewitt, 1997). Physics education should be examined closely for biases that may exclude particular learners. Classroom education of any sort consists of three general parts: curriculum, instruction, and assessment. Science curriculum and instruction have been closely scrutinized for gender bias and many positive changes have been made. Textbooks now include pictures of female scientists (Bazler & Simonis, 1990; Potter & Rosser, 1992), and teachers are more aware of the challenges and problems facing girls in education (AAUW, 1995 and 1999). Other aspects of science teaching receive less attention, particularly physics tests and assessments that could be contributing to the unwelcoming atmosphere of the physics classroom.

The question this research project addressed was whether gender-biased contexts in a particular physics assessment could contribute to gender gaps in performance.

Background

The issues surrounding women and science have been much discussed over the last few decades. These discussions have taken many forms. One branch has been the dialogue about the masculine nature of science and how that has affected women's participation in science and the growth of science itself. Londa Schiebinger (1999) gathers much of this debate together in her book "Has Feminism Changed Science?" Science, particularly the "hard" sciences such as chemistry and physics, are typically thought of as being objective, unbiased. Historically, it has not been considered that who does the science might affect the science itself. Yet Schiebinger, Evelyn Fox Keller, and others suggest that this is not the case. Throughout history women have been excluded from science via many different means. The lack of women in science has led to masculine theories and interpretations. One example would be the use of gender to define botanical groupings and the use of sexual metaphors in botanical reproductions (Schiebinger, 1991). Why would plant reproduction be anything like human reproduction? The male researchers created a gendered situation where a nongendered explanation might have sufficed; and their gendered taxonomy ranked "male" parts of a flower higher than "female" parts. This is just one example of how gender has unnecessarily infiltrated aspects of theoretically objective science.

Physical science can be shown to also have inherent masculine or sexual characteristics. The building of atomic and hydrogen bombs during the Second World War shows just how gendered science can be (Cohn, 1996). The creators of the bombs spoke of giving "birth" to the bombs, and the babies were of course male: Fat Man and Little Boy. The language surrounding the creation of the bombs was strikingly sexual: "…lectures were filled with discussions of vertical erector launchers, thrust-to-weight ratios, soft lay downs, deep penetration…" (Cohn, p. 189). Neutral objective science, indeed.

Other critics of masculinist science have included Donna Haraway, Sandra Harding, and Ruth Bleier. Bleier edited a thoughtful collection of articles in "Feminist Approaches to Science," printed in 1986. Among these are included several critiques of science ranging from epistemological critiques to classroom and educational critiques and assessments of sex differences research. The spectrum of discussions and critiques of science has been wide-ranging over several decades of research and thought on science and gender. Taking a different point of view, Wertheim (1995) posits that the connections between religion and science have also served to keep women out of science. In general, it is now understood that science is not as objective as it was once perceived. Who the scientists are affects how the science grows and what the science is.

Taking feminist and masculinist science ideas into the classroom, Sue Rosser argues that the science classroom is also heavily gendered and the masculine nature of science classes contributes to the lack of women in science (Rosser, 1986). The standard model of teacher as source of wisdom and student as recipient of wisdom is very traditional and tends towards the masculine, particularly in light of the dearth of female science teachers. Rosser contends that using women's studies methods, theories, and pedagogies in the science classroom might serve as a way to attract and retain female students (Rosser, 1990). Cathy Middlecamp (1999, 2000) applies feminist pedagogies in the sciences by using interactive activities and allowing students to determine both questions and answers, in an effort at making science more friendly to women and others.

Gender gaps in assessment have been studied for some time. Many gender researchers are familiar with claims of gender bias against the Scholastic Aptitude Test (Wilder & Powell, 1989 and Navarro, 1989). The Educational Testing Service conducted a study in which they argue that national tests are not biased yet admits that there are persistent gender differences (Cole, 1997). Others have argued that gender gaps on tests are not due to bias but due to innate gender differences (e.g., Benbow & Stanley, 1980).

Eighth graders in the US show no gender gap in mathematics nor in science, according to the Trends in International Math & Science Study (US DOE, 2000). Other studies show that the gender gap tends to show up at higher grade levels (Cole, 1997; AAUW, 1999). Connected with the gender gaps in assessment are gaps due to other factors such as race and socioeconomic status. Of further interest is the TIMSS data showing that among US eighth graders, larger family wealth correlates with a better science score. Also noted in the TIMSS study is that white students outscored Asians, Hispanics, and African-Americans. Race remains an issue in other standardized testing as well ("This Wasn't Supposed to Happen" 1999; Hall & Davis, 1999) and arguments about assessments actually testing for culture, not content, persist (Gleaves, 1994).

Deeper research into gender differences on tests has produced quite interesting results. In a recent report, Buck et. al. (2002) found that male and female students taking Advanced Placement tests show a significant tendency to do better on questions in content areas favoring their gender. Men did better on questions relating to war, politics and history, among others, while women did better on arts and literature topics, religion, and women's issues.

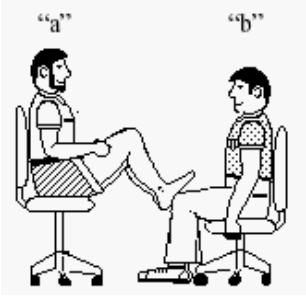
The issue of context of science questions has been less well studied. Rennie and Parker (1993) studied context in physics problems and found that teachers can create good gender-neutral or gender-inclusive assessment tools by looking at language, portrayal of stereotypes, and particular contexts. The students' reactions suggest that

appropriate contexts make problems easier to visualize and more interesting (Rennie & Parker, 1996 & 1998). Concrete problems were preferred over abstract problems. An example of an abstract problem statement follows: "An object is propelled vertically into the air. The object has its maximum potential energy…" whereas a contextualized version starts: "There is a big fireworks display over the Swan River near the city on Australia Day. One rocket is launched into the air…" (Rennie & Parker, 1998, p. 121)

In a South African study of context, Enderstein, et. al. (1998) found that in South African pupils, changing the context of a physical science question substantially affected the responses they received from the pupils. They had changed questions to better target the experiences of urban and rural pupils. Problems with humans or human perspectives elicited different responses than problems without human figures present.

Another good piece of evidence for the contextual dependency of performance lies in a story related by a colleague teaching in Thailand (personal correspondence). He gave the test under consideration to his students, but was unprepared for their response to the question referring to the situation of a person putting his bare feet on another person's knees (see Figure 1). This act would be extremely rude in Thailand, where the feet are considered an unclean part of the body. The students had severe trouble answering this question because the situation was so unbelievable to them. The *context blocked the physics*.

Figure 1. Picture from question on conceptual test



The present study looks at a particular physics assessment test, the Force Concept Inventory (Hestenes, Wells, & Swackhamer, 1992). The test is a thirty-question, multiple-choice conceptual test, which covers the topics usually found in the first semester of introductory physics courses. There is minimal math required to answer the questions and the non-correct answers (distracters) were written based on physics education research on common student misconceptions. The FCI is used across the United States in high schools, colleges and universities. Some instructors give course credit for taking the test; others make the test un-graded and/or voluntary. The most common use for the test is to assess the instructional effectiveness of the course. The FCI has been shown to correlate strongly with pedagogy (Hake, 1998).

The FCI has a significant gender gap favoring male students (McCullough, 1996 and McCullough & Crouch, 2002). This gender gap is not explained by physics background; when broken out by previous physics coursework men receive higher scores than women at each educational level. Nor does a course in physics ameliorate the problem; the gender gap is maintained from pre-instruction to post-instruction.

If women are receiving artificially lower scores on this test because of contextual bias, then not only is the test doing them a disservice, but it is also an inappropriate measure of instructional effectiveness for instructors and educational researchers who use the test. The goal of this research is to determine if context affects performance, and if so, to develop a version of the test in which context does not contribute to the gender gap on the test.

Methods

In order to determine if the contexts of the questions were affecting performance, the context had to be separated from the physics. A direct way to do this was to create a new version of the test in which the physics was kept identical to the original but the context of each question was changed. The original test used mostly male persons and either male-oriented or school- or lab-oriented contexts. Questions about rockets, cannonballs, hockey and male figures were included alongside questions about steel balls rolling off a horizontal table. The revised version of the test, called the Revised FCI or RFCI, used *stereotypically* female contexts such as shopping, cooking, jewelry and stuffed animals. Every figure and person mentioned is female. The contexts were pushed as far female-centric as manageable. This was done so that if performance exhibited context-dependence it would be as visible as possible. If only small changes in context had been made, corresponding small changes in performance might not have been detectable within the small populations under study. If large changes were made and large changes in performance were seen, then there would be more reason to believe that context did have an effect on performance.

The other significant change made to the test was to make the abstract, school-oriented contexts more concrete and closer to daily-life situations. As mentioned above, research (Rennie & Parker 1998) has found that female students prefer more concrete problems. Context-less problems such as a nondescript ball being thrown were changed to be more specific.

The RFCI was pilot-tested in several populations and revisions were made based on problems found in the test, such as a figure which was too big to be usable and a context which was not quite identical to the original in a physics sense (McCullough 2001). The version of the RFCI used in this study was the third version of the test. The physics of each question is the same as the physics in the original to the extent that this assessment is designed to test. For example, minor issues such as air resistance are ignored by most people who use this test.

The population chosen for the study was a group of non-physics students in general education classes such as English at a mid-sized Midwestern state university. Because this study was concerned about context, the context of the class was also a concern. Physics classes are male-dominated and may be a contributor to female under-performance. Claude Steele (1997) has found that cuing people in on gender in gender-discriminatory situations such as math and science testing can cause the minority population to do more poorly. This “stereotype threat” was a significant concern in this study. In order to reduce the possible gender-discriminatory cuing, non-physics classes were chosen and the test was introduced in a way that didn’t mention gender at all.

With IRB approval, eight classes were chosen based on the instructor’s willingness to give up class time to this project. Five were English or Literature classes, two were

Sociology classes, and one was a math class. In all but one class the researcher herself explained and administered the test using prepared notes (not a formal script). For the other class, the instructor introduced the study using a more formal script covering the same points. Taking the test was voluntary, but less than 5 students chose not to take the test.

Both versions of the test were used and were handed out in alternating order (A-B-A-B) so that students sitting next to one another had different tests. That there were two versions of the test was not mentioned. Students answered the test questions on a separate answer sheet which included nine demographic questions on the back. Students were asked about 15 minutes into the test to answer the demographic questions after they finished the test questions. This was done to again minimize the stereotype threat. The demographic questions included: previous physics and math courses taken, major, year in school, gender, years of high school math and science, and semester courses of college math and science. A total of 312 students participated in the study.

Results

An initial look at the overall scores of the four groups shows that changing the version did not significantly change the scores of the women, though there was a measurable difference in the male students' scores. Table 1 lists the average percent correct for the four groups under consideration.

Table 1. Average percent correct by test version and gender (Number of students and standard deviation)

	Original FCI	Revised FCI
Men	33.7 (N=56, sd=14.4)	28.5 (N=71, sd=11.7)
Women	21.7 (N=106, sd=9.7)	22.3 (N=79, sd=8.1)

The difference between the women's scores is not significant ($p>.05$). The difference between the men's scores is significant ($p=.005$) in favor of the original version. Changing the context of the questions towards more female-oriented contexts negatively affected the overall male score while having no effect on the overall female score. An initial interpretation of this result could be that women are less affected than men by changes in context. However, the literature does not support this interpretation, suggesting a need for closer examination of the data.

These somewhat unexpected results suggested that a closer look was needed. The next step of analysis was to look at each question and analyze student performance by men and women on both versions. The item analysis leads to a different interpretation of the effect of the version change.

The first question asked for the question-by-question analysis was this: on how many questions did women improve on the revised gender version? Looking at the number of women who got each question correct on each version, women did better on the gender version on 13 out of the 30 total questions. In contrast, men did better on the gender version on only 5 questions. There was no change in the women's or men's

scores on 2 questions. Another way to view this is to say that the gender version *decreased* or depressed women's scores on 15 questions and men's scores on 23 questions. This is in accordance with the overall results which suggest that the gender version hurts men's performance but neither helps nor hinders women's overall performance.

Why might this be happening? Perhaps women are so acclimated to bias in their science texts and tests, that they do not even consciously see the bias, and so it matters little to them. Or men may be so accustomed to male contexts that it shakes them out of their usual habits and thinking patterns to see the bias reversed. Alternatively, men may be more context-sensitive in general than women. It also should be noted that women's scores were close to what would be achieved by random guessing; since the scores are so low, it might be that we are seeing different patterns of random guessing among the women. Men's slightly higher score may be reflecting more thought going into the questions, which might increase the effect of context. However, since the FCI was designed to draw out students' right and wrong ideas, and the incorrect answers (distracters) were specifically chosen to be common misconceptions, it is unlikely that random guessing can explain this effect.

The next layer of analysis was to determine if there were particular questions with notable performance patterns. Were there questions where women improved but men did not? Vice-versa? The answer is clearly a resounding yes. Every combination of relationships imaginable showed up in the test. Particular questions serving as examples are shown below. Because the authors of the FCI are very concerned about the test becoming easily available to students, which they believe would reduce the test's usefulness I will not include the actual questions on the test. Educators can download the test by visiting the FCI website (see references) and requesting a password.

Cannon/bowl: The original question asks about the path of a cannonball fired off the top of a cliff. The picture shows a figure, more male- than female-looking, firing the cannon. The revised question asks about the path of a bowl shoved by a (female) baby off her high chair. The physics is identical between the questions at the level of analysis asked of the students. The only difference is the *context*. The results in Table 2 suggest that changing the context helped the women without hurting the men.

Table 2. Percentage of students choosing correct answer on cannon/bowl question by test version and gender.

	Original	Revised
Women	34	51
Men	66	66

Balls/oranges: Another question asks students about two steel balls rolling off a table and how far from the table they hit the floor, given that one ball weighs twice as much as the other. The revised question simply changes the balls to oranges, and inserts the modifier "kitchen" before "table". This change was one of the "daily-life experience" changes, to make the question less formal and school-oriented and more informal and familiar. Here, the revision actually increased the gender gap on the question, as seen in Table 3. The women performed more poorly on the revised question, while the men

performed better on the more female-oriented question. This makes drawing conclusions more complicated.

Table 3. Percentage of students choosing correct answer on ball/orange question by test version and gender.

	Original	Revised
Women	25	18
Men	25	37

Ball in channel/waterslide: A different pattern was seen on a question asking about the path taken by a ball exiting a horizontal circular channel. The original question gives a paragraph of introduction describing the setup (a frictionless horizontal circular channel is secured to a table top; the ball enters the channel at high speed and exits at the end of the channel). The revision involved changing the situation to a girl on a water slide; the last section of the slide is a horizontal circular arc. Again, the physics of the situations is the same. The path of a ball and a girl as they leave the circle are the same. In this case, the revision improved the women's scores while depressing the men's scores.

Table 4. Percentage of students choosing correct answer on channel/waterslide question by test version and gender.

	Original	Revised
Women	46	53
Men	77	67

The remaining questions show all the possible patterns: women up, men same; both same; men up, women down; etc. The single all-encompassing result of this study is that changing the context can and does affect student performance, but in ways that are hard to predict in terms of gender bias.

Discussion

The context in which a question is couched can affect how a student responds to that question. Replacing male-oriented contexts with female-oriented ones did reduce the gender gap on a popular physics conceptual test. This came at the cost of lowering men's performance rather than raising the women's. There are several interpretations of this data. Women may be accustomed to male-oriented examples and are less disturbed by changes to more female-oriented contexts. Perhaps the stereotypical contexts chosen (in 1998) do not match with current young women's worlds, and so there remains a mismatch in contexts for the women, but the contexts are far enough away from men's experiences to make them uncomfortable. What is certain is that context does interact with gender to affect how students perform on test questions.

The current version of the Revised FCI is not yet ready for answering the question of whether or not the context of the questions is lowering women's scores. What has been shown is that context does affect performance. The next steps in this research are to

further investigate how context affects performance. Interviews of students answering the same questions with different contexts are being planned. Also planned are shorter versions of the test which include both contexts for some questions.

Since the test is used primarily by physics instructors in physics classes, the Revised FCI must be tested with physics students and this is already underway at six different institutions across the country.

The underlying issues of this study have implications for instructors at many levels. When writing tests, instructors need to be aware of possibly biased contexts in their questions, not only for gender but for culture as well. Asking a question about a pop-fly baseball can alienate not only women (and men) not interested in the sport but students from other cultures who may not even know what a baseball is. In textbooks, back-of-chapter questions should be examined for their gender and cultural context and appropriateness to the students at hand. Questions about such things as driving on ice may be inappropriate for students who come from warmer climates. Even in day-to-day discussions and examples, instructors need to be aware of how the contexts they use may be affecting some students' learning and understanding.

The context of a question can affect how a student interprets, relates to and responds to that question. Further research is needed to examine more thoroughly the connection and relationships between context and response. The current research suggests that teachers need to be aware of the contexts they use in their classrooms, so that they do not inadvertently disadvantage the women they teach. By learning more about context and contextual bias, our classrooms can become more accommodating to women and we can invite broader participation of women in science and in science classrooms.

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Judith Merril and Rachel Carson: Reflections on Their "Potent Fictions" of Science

By Dianne Newell

Abstract

Donna Haraway has argued that women's engagement with the masculine domain of science and modern culture usually occurs at the peripheries and from the depths, not from the platform of the powerful. This paper considers the popular culture fields of science fiction and nature writing, exploring the contributions of two American women writers who both operated at the peripheries of science *and* landed on the 'platform of the powerful': Judith Merril and Rachel Carson. Their domestic Cold War envisioning and conflation of literature and science and their insights into the inherently political nature of science anticipated the foundational feminist discussions on the intersections of feminism, literature, and science that followed in the 1970s and 1980s. Merril's postwar, literary avant-garde ideas together with the stories of the later American feminist science fiction writers prompted Haraway's challenging suggestion in her transformative study, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (1989) that we might read natural science as a narrative--potent fictions of science--and listen to scientists as storytellers. Rachel Carson, considered the founder of the modern American environmental movement and the author of the famous polemic *Silent Spring* (1962), had advocated the idea of natural science as narrative decades earlier. The paper traces how Carson links to Merril indirectly and Haraway to Merril directly. In the Cold War decades, both Merril and Carson struggled successfully from and within the margins of science to reshape literatures dealing with possible futures and alternative presents.

Key Words: science fiction, nature writing, Judith Merril, Rachel Carson

Introduction

Women's engagement with the masculine domain of science and modern culture usually occurs at the peripheries and from the depths, not from the platform of the powerful, suggests a leading feminist theorist and historian of science, Donna Haraway.[1] Historians and philosophers of women in science, such as Pnina Abir-am, Evelyn Fox-Keller, and Londa Schienbinger, have taken a long look at women in the past who actually 'do' science. My interest here, however, is in developing a political reading of women science writers' engagement with science at the peripheries of scientific thought and developments in a 'pre-feminist' era: the decades after the Second World War. I consider the popular culture fields of science fiction and nature writing, adjusting the focus on two American women science writers who both operated at the peripheries of science *and* landed on the 'platform of the powerful': Judith Merril and Rachel Carson. Their domestic Cold War envisioning and conflation of literature and science and their insights into the inherently political nature of science anticipated the foundational feminist discussions on the intersections of feminism, literature, and science that followed in the 1970s and 1980s. Indeed, Haraway's own revolutionary studies of the historical, social construction of Western scientific knowledge discovered, borrowed, and adapted science fictional approaches and incorporated Merril's imaginative concept, 'SF.'

Judith Merril (1928–1997) in her Cold War science fiction and nonfiction writings effectively challenged the prevailing science-adventure ('hard') mode of science fiction and promoted novel approaches to fiction about possible futures that struggled to put a human face on the abstract problems of new, seductive and terrifying, sciences and technologies. In her words, 'the industrial, political, and technological space age meant the beginning of a new period of

exploration in "the human factor," as opposed to the "hardware," for both science and science fiction.'[2] Her novels and short works of speculative fiction of the late 1940s and the 1950s advanced an overtly woman's point of view on critical issues of the day. By the early 1960s, even before the blossoming of feminist science fiction, Merril had become the foremost female editor-critic and experimentist, and perhaps most political individual in North American science fiction circles. Merril's work links her intriguingly to the contemporary and celebrated Rachel Carson (1907–1964). Carson excelled in the 1950s in developing the human factor in natural science literature. Prior to her most influential book, the anti-pesticide polemic *Silent Spring* (1962), Carson was a prize-winning science writer – early in her career also a government marine biologist and (mostly) editor and writer on wildlife.[3] *Silent Spring*'s apocalyptic vision of a world destroyed by its own citizens resonated with the radical science fiction writings of the day. Significant commonalities appear in the iconoclastic approach of these two women to science writing in the postwar era, each a leader in her respective field.

Merril's SF: Fiction That Seeks the Meaning in Science and Our Scientific Society

Modern science fiction, which emerged in the American pulp magazines (small format, garish serials printed on cheap paper) in the 1920s, developed as a grouping of story types.[4] The hybridization and eclecticism in science fiction during the early domestic Cold War occurred over two short phases. In the most intense political phase, new writers entered science fiction in the late 1940s and early 1950s. Then new forms of science fiction writing, new mass-publishing venues, and critics and a second round of new writers emerged at the end of the 1950s and the early 1960s. Both phases in the evolution of science fiction correspond to what Paul Boyer in *By the Bomb's Early Light* identifies as the first two phases in a series of Cold War public activism events around atomic war and radioactivity issues.[5] Both phases also attracted many women to the field.[6] For the women in early postwar science fiction such as Judith Merril, the various phases and waves also overlapped with the so-called break between the first and second waves of the women's movement.

Merril's recently published memoir, *Better to Have Loved: The Life of Judith Merril* (2002), highlights her original goal in science fiction in the late 1940s. It was to write a type of sociological science fiction that grappled with the new political and social issues of the domestic Cold War and the Space Age.[7] This stated objective is consistent with the archival evidence she left behind. In *American Science Fiction and the Cold War* (1999), David Seed makes Merril's first novel *Shadow on the Hearth* (1950) central to his discussion of the suburban home as a refuge. He pushes this idea further in a more recent paper, 'The Debate Over Nuclear Refuge' (2002) by showing how *Shadow on the Hearth* connects to the contemporary work of scientists such John Hersey (*Hiroshima*), David Bradley (*No Place to Hide*), and Philip Morrison ('If the Bomb Gets Out of Hand,' in Dexter Masters and Katherine Way, eds., *One World or None*) in an original way. Unlike male writers, 'Merril has no interest in trying to capture the spectacle of the blasts, only in exploring their consequences for a typical suburban household.'[8] Merril's correspondence with Bradley in 1949 reveals her purpose in departing from the norm; she wanted to appeal to women readers: 'Women LOVE to read about diseases […] and also about dangers to their children, homes, and family,' she writes. Merril adds that Bradley's *No Place to Hide* was in truth 'a man's book, with little appeal for women.'[9]

Merril likewise intended her first published story, 'That Only a Mother,' (1948), about the differential reactions of parents to their limbless, super-intelligent infant, as a 'women's point of view.' She writes, 'It was an extremely unpleasant story about the possible (probable?) effects on one small ordinary family of life during a comparably 'clean' controlled atomic war in (what was then) the near future […] the more insidious after effects—the cancers and leukemias that might

follow years later for apparently untouched survivors; the lingering radioactivity; the sterility and mutations […].'[10] Merril possibly intended the central figure of the story, the mother who refused to acknowledge her baby's deformities, to represent the scientists in post-Hiroshima America who refused to acknowledge the devastating effects of atomic radiation.[11]

Reception for Merril's relatively modest corpus of science fiction novels and short fiction works, all of it produced between 1948 and 1963, has always been mixed. In its day, her early fiction received critical attention, though a leading critic and colleague, Damon Knight, dismissed her later fiction as sentimental, romantic, and, in the extreme view, 'sweat-and-tears-and-baby-urine variety,' 'kitchen-sink' science fiction.[12] Merril's fiction did not fare better at the hands of the 1970s wave of feminist science fiction writers and scholars. They tended to trivialize Merril's work, along with that of most of the early women science fiction writers, one way or another.[13] Most of the early women writers worked within masculinist paradigms. Merrill, on the other hand, eschewed masculinist conventions and placed family relationships at the centre of her stories. In different ways, each of these strategies is unsatisfying to many feminists: the former reifies masculinist generic conventions; the latter reifies the narrow identification of the female writer with domestic themes.

Feminist opinion on the significance of women's early science fiction stories has continued to bounce around. In the 1990 *Encyclopedia of Science Fiction*, American-born British science fiction critic-writer Lisa Tuttle classified (and dismissed) Merril among those early women writers in science fiction whose female protagonists are too conventional. Yet the trend is changing. A new generation of feminist science fiction writers and critics are re-evaluating not only the role of the early women writers, especially Merril, but also the role of 1970s feminist science fiction writers in the erasure of those women from the memory of the feminist project. Both Connie Willis, as an American critic-writer of science fiction, and Helen Merrick, as an Australian science fiction scholar, for example, blame the first generation feminist writers such as Russ for creating an invisible wall, as it were, around the laudable activism of pre-feminist science fiction writers such as Judith Merril[14]

Regardless of the relative merits of Merril's science fiction, whether her dark post-nuclear holocaust fiction stories or her optimistic stories on the colonization of space that followed, her criticism and editorial work proved to be Merril's major preoccupation and source of posterity and political influence. Merril's nonfiction writing, especially her annual anthologies and critical reviews of science fiction and science fact, received overwhelming respect in their day. Her male contemporaries (whatever they thought of her fiction writing) referred to Merril as a science fiction connoisseur. It was Merril's nonfiction writings on science fiction, not her science fiction stories *per se*, that would catch the eye of Donna Haraway several decades later. Thus, intrinsically and for their influence on Haraway, Merril's nonfiction writings warrant further discussion here.

From the early 1950s onward, Merril took every occasion in her role as anthologist, critic, and editor in book and magazine publishing to revolutionize science fiction as a powerful, creative, potentially radical genre. It is what she (and, later, because of her, Haraway) referred to in capitalized initials as 'SF.' Merril first set the standard for SF both in her own fiction writing and in her fantasy/science fiction theme anthologies published before 1955. She then formulated arguments about SF in the second half of the 1950s, when she launched and edited what would prove to be a popular major annual anthology of previously published science fiction stories, *SF: The Year's Best*. Merril's *Year's Best* for 1959, in particular, promoted her idiosyncratic and

entertaining--but with an underlining seriousness, in the manner of all good science fiction--explanation of SF. Merril writes:

SF is an abbreviation for Science Fiction (or Science Fantasy). Science Fantasy (or Science Fiction) is really an abbreviation too. Here are *some* of the things it stands for…
S is for Science, Space, Satellites, Starships, and Solar exploring; also for Semantics and Sociology, Satire, Spoofing, Suspense, and good old Serendipity. (But *not* Spelling, without which I could have added Psychology, Civilizations, and *Psi* without parentheses.)

F is for Fantasy, Fiction and Fable, Folklore, Fairy-tale and Farce; also for Fission and Fusion; for Firmament, Fireball, Future and Forecast; for Fate and Free-will; Figuring; Fact-seeking, and Fancy-free.
Mix well. The result is *SF*, or *Speculative Fun*…
Happy reading.[15]

Merril's passion for exploring the creative and critical promise of the genre found its greatest expression in the mid-1960s British-based new wave of 'soft' science fiction using modern styles of writing. After spending a year with London-based new wave writers and publishers in the mid-1960s, she became the North American promoter and defender of the small but controversial approach. She produced a seminal essay in 1966 about the superiority of SF ('experimental,' 'daring') over mainstream science fiction ('s-f') for the first journal of science fiction criticism, *Extrapolation*; the piece gained a second life when later anthologized in Thomas Clareson's seminal collection on science fiction criticism, *SF: The Other Side of Realism* (1971).[16] By this historical juncture of new wave science fiction and the gathering second wave of the women's movement at the end of the 1960s, the feminist science fiction of Joanna Russ, in particular, Ursula K. LeGuin, and a handful of other new women in science fiction literature gained notice in the field.

Although not engaged in feminist politics *per se*, Merril understood both the politics of mythologizing and the unique role of science fiction, reconfigured as 'SF,' as modern myth. In her 1967 science fiction annual anthology, *SF: Best of the Best*, she appears to struggle with the evolving issue of the nature of science fiction literature – with its ever widening inclusiveness (hence, what to name it), the science in science fiction, and, especially, with the role of science fiction as modern myth:

More recently there has been much talk (from me among others) about SF as modern myth. It may seem pretentious to speak of a field which degenerates so readily into mere adventure story as the replacement for classical philosophy in our time – and yet this is to some extent the role s-f has been playing. Science-fiction is not fiction about science, but fiction which endeavors to find the meaning in science and in the scientific-technological society we are constructing.[17]

Finding the meaning in science and the scientific society under construction encapsulates Merril's radical vision of the critical role for science fiction at the end of the sixties.

Merril understood – and tirelessly promoted – the subversive nature of the genre: 'I do not mean just in its special uses as a vehicle of political analysis and social criticism,' she cautioned, 'but in its essential character. A literature dealing in possible-futures and alternative-presents, concerned with how things *might be*, rather than how they are, is inevitably (in any state short of Utopia) going to stir up some degree of dissatisfaction with the world-as-it-is. And just as certainly it will attract writers with vigorous opinions about how things *ought* to be.'[18]

Merril had for her part launched and nurtured the move away from the traditional male model of 'hard' science fiction, with its concern with getting the science right. The science

fiction envisionings of alternative futures by Merril and her circle were, according to Boyer, everywhere 'in the air' by the late 1950s. To live in the modern world was to know science fiction ideas and icons firsthand, a point not lost on Rachel Carson when writing *Silent Spring*.

Rachel Carson: The social obligation of nature writing

Rachel Carson had no formal connection to Merril, was likely not a fan of science fiction, and did not live to see feminist critiques of science. Yet, she recognized the persuasive power of the science fiction form in telling an apocalyptic story about science. Like Merril she was a daring, experimental writer of the postwar era, and her influence over the public debate about science and society has been international in scope and enduring. Like Merril, she, too, endeavored from the margins to find the social meaning in science.

Carson always promoted the importance of a story-telling quality in nature writing. She once even claimed that in college her ambition to be a writer barely lost out to her passion for natural history.[19] She was also proud of the literary content of her science writings. She always credited the literary merit of her work for her ability to reach a large, popular audience of non-specialists with her science stories of the natural world. She was already an innovative, national best-selling author in the natural sciences well before the appearance of *Silent Spring*.[20] By the early 1950s, she had won major awards and honorary doctorates in both literature and science, and membership in the American Academy of Arts and Letters, which was unusual for a woman, let alone a scientist. Hers was a remarkable, pre-feminist success in lowering the barriers, not just between women and science, but likewise between science and literature.

Carson's attention to literary matters, to poetics and emotion, to fostering a sense of wonder in her science writing represented a political choice, political in the sense of challenging established ideas about her field. Ceremonies for Carson's prestigious book award and the political and policy upheavals in her own government service in the early 1950s provided her with opportunities to speak her mind as an advocate for the natural world and – much as Merril had – to speculate about *possible* futures. Carson's recent biographer, Linda Lear, notes that Carson used the occasion of accepting the National Book Award for Nonfiction in 1952 to comment on her concern with the trend toward the 'artificial separation of science and literature as exclusive methods of investigating the world.'[21] For Carson, 'the aim of science is to discover and illuminate the truth,' which was for her the objective of all literature.[22] Carson's conclusion that 'there can be no separate literature of science' was both unusual for the times and a harbinger for the feminist debates about science to come.

Carson continued the theme when accepting the John Burroughs Medal for excellence in nature writing the same year. On that occasion she argued that natural science writing as public education was an urgent need if Americans were to prevent the type of human isolation in increasingly artificial, 'man-made' worlds, isolation that fostered what she chillingly described as 'experiments for the destruction of himself and his world.'[23] She underscored her message about the social obligation of nature writing in the atomic age: 'If we have ever regarded our interest in natural history as an escape from the realities of our modern world, let us now reverse this attitude. For the mysteries of living things, and the birth and death of continents and seas, are among its great realities.'[24]

Carson's anti-pesticide study, *Silent Spring*, reflects the hand of the same thoughtful, inventive writer and visionary. It also demonstrates her continuing resistance to the idea of a separate literature of science. Nevertheless, it is much bolder and experimental than her earlier writings. Lear argues that its polemical nature was a major departure from Carson's earlier writing, because in it 'Carson […] attacked the integrity of the scientific establishment, its

moral leadership, and its direction of society. She exposed their self-interest as well as their poor science and defended the public's right to know the truth.'[25] Carson had wanted the book to make a difference, and, as is well known, it did. *Silent Spring* launched the modern environmental movement,[26] has been compared with Charles Darwin's *On the Origin of Species* for the scope of its challenge to the dominant scientific paradigm, and it remains one of the most important American books of the twentieth century.[27]

Carson arrived at this departure from her usual nature writing by grounding her radical analysis of the dangers posed by the indiscriminate use of synthetic pesticides in a difficult maze of obscure scientific studies and investigative journalism. Her wartime role as an 'information specialist' and a government editor and writer of fish and wildlife research publications had already exposed her to early classified government science on the dangers to wildlife and human health of the DDT pesticide range. Her former editorial role in government, which might seem on the surface to have been an inferior position, given her training as a marine biologist, proved a tremendous asset after she left government service in the early 1950s for a career as an independent scholar-writer. It gave her the access to the classified core research and to the researchers she needed for her controversial new study that her free-lance position might have prevented.

The writing of *Silent Spring* from 1957 to its publication in 1962 would also draw Carson into a dynamic shifting network of concerned, tenacious, and unusually influential women on the margins of science in the United States, Canada, and Britain. These women both prompted and advocated Carson's study. The book project was thus Carson's entrée into an expanding world of women activists in North America and Europe, though she would die of breast cancer in 1964 before she had a chance to enter fully into that powerful arena. Several of these women are identified by Linda Lear in her writings on Carson, as well as by Carson herself. She writes in *Silent Spring* of the influential appeals of her friend Olga Huckins, whose private bird sanctuary was poisoned by pesticides in the 1950s in an aerial spraying campaign for mosquito control. The early stages of Carson's research for the book and the articles and letters she published at the time drew the attention of *Washington Post* newspaper owner Agnes Meyer, and activist Christine Stevens, who was president of the Animal Welfare Institute of New York. Stevens recognized the value of Carson's special qualities as a nature writer for environmental causes, writing to Carson: 'All humanitarians will be grateful to you for writing on this subject, for your great gift as a writer combined with those of a biologist would make your efforts of inestimable value in putting a stop to these poison campaigns.'[28] She introduced Carson to the work of British environmental activist Ruth Harrison, whose exposé of the inhuman treatment of livestock when published in 1963 would carry a preface written by Carson.[29]

Carson constructed this extraordinary book in the second wave of nuclear awareness and concern, which Boyer suggests now 'surfaced at all cultural levels.'[30] Examining the impact of the bomb on Carson's anti-pesticide narrative, Ralph Lutts concludes that Carson most certainly counted on that public awareness and fear of radioactive contamination in constructing the story line of the book.[31] Carson used the popular narratives of the day (fear of nuclear war and radiation sickness, invisible killers, hidden persuaders), drawing parallels between the effects of atomic radiation and those of chemical pesticides, and the persuasive power of mass advertising. All of them were major topics in mass-marketed science fiction, thanks to the radical Cold War science fiction writers such as Judith Merril.

Finally, in her attention to the literary quality of her science writing, Carson also employed science/speculative fiction-like conventions and ideas that were 'in the air' – although there is no evidence to support the idea that she did so intentionally. On the contrary,

fragmentary evidence exists to suggest that Carson was not familiar with science fiction literature and not even interested in getting to know it.[32] Yet, like her postwar contemporaries in science fiction, she would have understood the appeal of images of the 'near future.' In science fiction practice, the near future setting is a world 'imminently real' (it could be tomorrow), in which people may someday live and must imaginatively prepare for in advance.[33] Taken as a whole, Carson's literary choices were unorthodox for a natural science writer.[34] They were also courageous choices. Some critics of the day disparaged *Silent Spring* as an entire work of science fiction (referring to the low regard in which science fiction was held, possibly even by Carson). Many of them scoffed at Carson's myth-like reputation as a goddess of nature (referring to the environmental and animal rights activists with whom she associated), called her emotional and extremist, questioned her integrity, sanity, and loyalty to the nation, even branded the 55-year old Carson a 'spinster,'[35] the ultimate heavy-handed insult leveled against women who stepped of bounds.[36]

No aspect of *Silent Spring* is more 'potent' than the prologue. Carson chose to write it as a fable, 'A Fable for Tomorrow.' The growing scholarship exploring the public response to *Silent Spring* is mindful of the contemporary appeal of Carson's apocalyptic vision and of the special role of the fable prologue in cementing that vision.[37] The near-future images in Carson's fable prologue are meant to appeal to a reader's creative imagination to end the destructive impulse that marked the reality of the postwar era, a reality about which she had been issuing gentle public warnings since at least 1952. The narrator of the book's science-fable prologue imagines a silent springtime in a world destroyed by its own citizens through the indiscriminate use of pesticides. Reverting to her own authorial voice in a final paragraph, Carson confides in readers that it is not too late for America to prevent the story in the fable. However, she wrote, 'a grim specter has crept upon us almost unnoticed, and this imagined tragedy [described in the fable] may easily become a stark reality we all shall know. What has already silenced the voices of spring in countless towns in America?'[38] The answer to Carson's powerful science-fiction-like question is the subject of the entire book.[39] The reader is hooked. What a science storyteller, in Haraway's positive sense of the term. And what a science story.

Haraway's potent fictions of science

Although Donna Haraway's 1980s historical analysis of natural history writing makes no reference to Carson, it could just as easily have included her. One of the large questions in Haraway's rather extraordinary study, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (1989) was already on Carson's mind in the 1950s: 'What may count as nature for late industrial people?' Merril is a different story. Haraway acknowledges Merril's critical writings directly and, to an extent, indirectly via feminist science fiction stories of the 1970s, with their tenuous connections to Merril's advocacy of experimental science fiction. These feminist science fiction stories also inspired Haraway's revisioning of science as a story-telling practice.

It is usual in science fiction to think of the late 1960s with the publications of Joanna Russ and Ursula K. LeGuin as the rough starting point of a noticeable influence, not merely a presence, of women writers and women's issues on science fiction. Then, the generation of American feminist science fiction writers who penetrated the field in the 1970s – 'informed,' as the American literary critic Sarah Lefanu writes, 'by the feminist, socialist and radical politics' of the day – embraced the radical and quite different political possibilities and limits of science fiction to advance feminist agendas concerning the impact of reproductive and other new technologies.[40]

The key American feminist science fiction writer and critic, Russ, argued as early as 1971, but a decade after Merril, that science fiction was a natural trail for any kind of radical thought and for presenting the concerns of a marginal group. She suggested that for her contemporaries in America, where female culture was present but still marginalized, men and women continued to view culture from a single point of view: that of the male. The literary myths were male myths.[41] Thus, science fiction was revolutionary in the 1970s because it offered feminist writers a chance to create alternate myths and metaphors. Science fiction was one of only a handful of genres to employ plots that transcended accepted gender roles and transcended culture, and, as she points out, went where some of the most 'fascinating characters' were not necessarily human.[42] For Russ, writing science fiction and criticism in the full bloom of the new feminism,

> Science fiction, political fiction, parable, allegory, exemplum--all carry a heavier intellectual freight (and self-consciously so) than we are used to. All are didactic. All imply that human problems are collective, as well as individual, and take these problems to be spiritual, social, perceptive, or cognitive […]. I would go even farther and say that science fiction, political fiction (when successful), and the modes (if not the content) of much medieval fiction all provide myths for this dealing with the kinds of experiences we are actually having now, instead of the literary myths we have inherited, which only tell us about the kinds of experiences we think we ought to be having.[43]

Marilyn Hacker in her introduction to Russ's writings in 1977 would observe that, thanks to Russ, feminist mainstream fiction writers had discovered the radical possibilities of science fiction: '[some of the] most imaginative, artistically successful, and convincing feminist fiction writers are discovering/borrowing/adapting speculative-fictional conventions and techniques.'[44]

The myth-making and myth-breaking possibilities of feminist science fiction that Russ and her circle advanced in the early 1970s influenced the critical thinking about science and feminist epistemology of the leading feminist thinkers who followed. Sandra Harding in *The Science Question in Feminism* (1986), for example, has famously traced the trajectory of feminist approaches to the philosophy of science and theories of knowledge from the mid-1970s reformist position (the 'woman question' in science), to the 1980s revolutionary position (the 'science question' in feminism). In other words, illuminating the shift from a concern for the situation of women in science to a radically different question: 'Is it possible to use for emancipatory ends sciences that are apparently so intimately involved in Western, bourgeois, and masculinist projects?'[45] Echoing Russ's and Hacker's earlier discussions indirectly, and Haraway's acclaimed essay, 'A Manifesto for Cyborgs' (1985), more directly, Harding refers to women's science fiction writings at one point in her epistemological text, offering the poignant suggestion for a feminist understanding of science: 'Perhaps we should turn to our novelists and poets for a better intuitive grasp of the theory we need.'[46] The science fiction novelists Harding turns to are Marge Piercy, *Woman on the Edge of Time* (1976), and Anne McCaffrey, *The Ship Who Sang* (1969), and she asks:

> What kind of understanding of science would we have if we began not with the categories we now use to grasp its inequities, misuses, falsities, and obscurities but with those of the biologist protagonist imagined by Marge Piercy in *Woman on the Edge of Time*, who can shift her/his sex at will and who lives in a culture that does not institutionalize (i.e. does

not have) gender? or with the assumptions of a world where such categories as machine, human, and animal are no longer either distinct or of cultural interest, as in Anne McCaffrey's *The Ship Who Sang?*[47]

Piercy's wildly popular *Woman on the Edge of Time* (1976) continues down to this day to be the outstanding example of what Hacker alerted us to: a 1970s feminist mainstream fiction writer's experimentation with the science fiction genre.

As Harding discovered, Haraway was interested in what she refers to as 'the narratives of scientific fact – those *potent fictions of science* – within a complex field indicated by the signifier SF.' Judith Merril was her inspiration to do so. Here is how Haraway in *Primate Visions* explains it: 'In the late 1960s science fiction anthologist and critic Judith Merril idiosyncratically began using the signifier SF to designate a complex emerging narrative field in which the boundaries between science fiction (conventionally, sf) and fantasy became highly permeable in confusing ways, commercially and linguistically. Her designation, SF, came to be widely adopted as critics, readers, writers, fans, and publishers struggled to comprehend an increasingly heterodox array of writing, reading, science fiction, science fantasy, speculative futures, speculative fabulation.'[48] Science fiction stories and Merril's imaginative concept, 'SF,' prompted Haraway's challenging suggestion that we might read scientific practice as essential story-telling practice and listen to scientists as essential storytellers. It was a path down which Rachel Carson had boldly advanced, though not actually interrogated, decades previously.

To begin to do justice to Haraway's thoughtful, linguistically complex, myth-exploding analysis of research into monkeys and apes in *Primate Vision* requires close attention to the central reasoning of her massive study:

> From only a slightly different perspective, the history of science appears as a narrative about the history of technical and social means to produce the facts. The facts themselves are types of stories, of testimony to experience. But the provocation of experience requires an elaborate technology – including physical tools, an accessible tradition of interpretation, and specific social relations. Not just anything can emerge as a fact; not just anything can be seen or done, and so told. Scientific practice may be considered a kind of story-telling practice – a rule-governed, constrained, historically changing craft of narrating the history of nature. Scientific practice and scientific theories produce and are imbedded in kinds of stories. Any scientific statement about the world depends intimately upon language, upon metaphor. […] Science practice is above all a story-telling practice in the sense of historically specific practices of interpretation and testimony.[49]

Haraway places her accounts of primatology within SF as 'an invitation for readers of *Primate Visions* to remap the borderlands between nature and culture.' She invites them (us) to behave like readers of science fiction and rewrite the text through the act of reading.[50] The concluding chapter of *Primate Visions*, 'Reprise: Science Fiction, Fictions in Science, and Primatology,' looks at how Joanna Russ, Marge Piercy, and several other female and male science fiction writers have 'provided one of the lenses for reading primatological texts.'[51] In the chapter's explosive final subsection, 'Reading Science Fiction as Primatology: Xenogenesis and Feminism,' Haraway examines, or as she puts it, 'perversely reads,' volume one of Octavia Butler's Xenogenesis Trilogy, the science/speculative fiction story entitled *Dawn: Xenogenesis* (1987), as though it were a monograph from the modern primate field.[52]

Haraway's debt to Judith Merril's 1960s experimental ideas about science fiction is significant – and novel – for a feminist scientist and historian of science. For one thing, with few exceptions the political critique and literary avant-garde ideas inherent in Merril's nonfiction writing went largely unnoticed until Haraway's discovery of them in the late 1980s. For another, Haraway's argument that 'placing the narratives of scientific fact within the heterogeneous space of SF produces a transformed field,' initiated Haraway's own extraordinary transformation of the fields of the history of science, cultural criticism, and feminist theory in the 1990s.

Conclusion

It is not difficult, though it is unusual, to speak of Judith Merril, Rachel Carson, and the later feminist science fiction writers and feminist philosophers and historians of science all in the same breath. For several decades before the establishment of feminist science fiction and feminist science studies, Merril and Carson had independently written about many of the 'subversive' science-nature and science-literature issues that feminists of the 1970s and 1980s subsequently addressed. In this respect, the great feminist writers on science fiction and science fact of the 1970s and 1980s did not represent a permanent break from the past. Domestic Cold War anxieties and the expansion of mass marketing in publishing provided Merril and Carson with openings to take science fiction and popular science writing, respectively and collectively, in experimental and politicized directions. These new directions displayed great imaginative power and demonstrated the potential for radicalism in their respective fields. Each in their own way struggled from and within the margins of science to reshape literatures, both fiction and nonfiction, dealing in possible futures and alternative presents. By the end of the 1960s both figures had left the scene. Carson died shortly after the publication of *Silent Spring*. Merril immigrated to Canada in 1968 over American military involvement in Vietnam. In so doing, she knowingly also relinquished her position of power and influence in the all-important American science fiction field. It would be left to future generations of feminist writers to 'find' the feminist meanings in science. In the greatly altered international political climate of the 1970s and 1980s, feminists such as Russ, Harding, and Haraway connected with a tradition of which Merril and Carson, taken across the broad spectrum, were formidable architects. The cumulative impact of these post-war female interventions from the margins into the nature, culture, and the social construction of science over the past five decades continues to shape and reshape Western visions about humans, machines, and nature – and the essential relations among them.

[1] Dianne Newell is Professor of History and Acting Director of the Peter Wall Institute for Advanced Studies, at the University of British Columbia, Vancouver, Canada. She delivered a version of this paper at the 10th Biannual Swiss Congress on Women's History: 'Gender and Knowledge,' University of Misericorde, Fribourg, Switzerland. Donna Haraway, 'Situated Knowledges: The Science Question in Feminism as a Site of Discourse on the Privilege of Partial Perspective,' *Feminist Studies* 14, no. 3 (1988), pp. 575–600; Haraway, 'Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s,' *Socialist Review* 15, no. 2 (1985), pp. 65–108. Both are reprinted (though with slightly altered titles) in Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge 1991).

[2] Judith Merril, ed., *SF: The Best of the Best* (New York: Dell, 1967), p. 5.

[3] See also my discussion of Merril and Carson in the context of the atomic bomb: Dianne Newell, 'Women Writing Natural Science and Science Fiction in an Age of Anxiety: Atomic Reading,' paper presented at the 5th Interdisciplinary and International Symposium on Gender Research: 'The Nature of Gender. The Gender of Nature.' Christian-Albrechts-Universität zu Kiel, Germany, 10–12 November 2000.

[4] Everett F. Bleiler, 'Introduction,' in Bleiler, ed., *Science Fiction Writers: Critical Studies of the Major Authors from the Early Nineteenth Century to the Present Day* (New York: Charles Scribner's Sons, 1982), pp. xi-xv.

[5] Paul Boyer, *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Nuclear Age*. First published in 1985 (New York: Pantheon, 2nd ed., 1994), new preface.

[6] Pamela Sargent was the first to reflect on the history of women science-fiction writers. Pamela Sargent, ed., *Women of Wonder. Science Fiction Stories by Women about Women* (New York: Random House, 1975), editor's introduction, pp. xiii-lxiv. See also Sargent, ed., *Women of Wonder: The Classic Years. Science Fiction by Women from the 1940s to the 1970s* (New York: Harvest Original, 1995), editor's introduction, pp. 1–20.

[7] Judith Merril and Emily Pohl-Weary, *Better to Have Loved: The Life of Judith Merril* (Toronto: Between the Lines, 2002); see also Brian Stableford, 'Judith Merril,' in John Clute and Peter Nicholls, eds., *The Encyclopedia of Science Fiction* (London: Orbit Press, Little, Brown and Co., 1990; 1999), p. 799.

[8] David Seed, *American Science Fiction and the Cold War: Literature and Film* (Chicago: Fitzroy Dearborn Publishers, 1999); Seed, 'The Debate Over Nuclear Refuge,' p. 15, unpublished essay cited with author's permission.

[9] Seed, 'The Debate Over Nuclear Refuge,' citing Judith Merril Papers, National Archives of Canada, Ottawa, Merril to John Bradley, 19 February 1949. See also Seed's interview with Merril conducted only months before her death: David Seed, 'One of Postwar SF's Formative Figures,' *Interzone* 126 (Dec. 1997), pp. 13–14, 26; see also Allan Weiss, 'Not Only a Mother: An Interview With Judith Merril,' *Sol Rising* [Toronto] 18 (April 1997):1, 6–9.

[10] Judith Merril, 'That Only a Mother,' *Astounding Science Fiction* (June 1948), and anthologized in over a dozen different collections and in four languages, including most recently Sargent, ed., *Women of Wonder: The Classic Years*, pp. 65–73. Quote taken from Merril, 'Prologue,' in Merril, *Survival Ship and Other Stories* (Toronto: Kakabeka, 1973), p. 5

[11] Personal communication with Elizabeth Hull, Chicago, 2 March 2003. Professor Hull tells me that she shared this interpretation with Merril in the 1970s, and that Merril found it 'interesting.'

[12] Damon Knight, *In Search of Wonder: Essays on Modern Science Fiction* (Chicago IL: Advent, 1956), p. 100; and see also Chris Morgan, 'Judith Merril,' in: Bleiler, ed., *Science Fiction Writers*, pp. 433–439.

[13] See for example, Victoria Lamont and Dianne Newell, 'House Opera: Frontier Mythology and Subversion of Domestic Discourse in Mid-Twentieth Century Women's Space Opera,' *Foundation: International Review of Science Fiction*, Vol. 33 (2004): forthcoming.

[14] Pamela Sargent, 'Introduction: Women and Science Fiction,' in Sargent, ed., *Women of Wonder* (1975), xiii-lxiv; Lisa Tuttle, 'Women SF Writers,' in Clute and Nicholls, eds., *The Encyclopedia of Science Fiction*, p. 1344; Connie Willis, 'The Women SF Doesn't See,' *Asimov's SF Magazine* 16, no. 11 (Oct. 1992): 4–8, 49; Helen Merrick, 'Fantastic Dialogues: Critical Stories about Feminism and Science Fiction,' in Andy Sawyer and David Seed, eds., *Speaking Science Fiction: Dialogue and Interpretation* (Liverpool: University of Liverpool Press, 2000), pp. 52–68.

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[18] Judith Merril, 'Introduction,' in *Path into the Unknown. The Best of Soviet Science Fiction* (New York: Dell, 1968), pp. 7–11 (here pp. 7–8).

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[20] For a bibliography of her published work, see Paul Brooks, *The House of Life: Rachel Carson at Work* (Boston: Houghton Mifflin, 1972), and Linda Lear, *Rachel Carson: Witness for Nature* (New York, NY: Henry Holt & Co., 1997).
[21] Lear, editor's introductory notes to Rachel Carson, 'Remarks at the Acceptance of the National Book Award for Nonfiction [for *The Sea Around Us*],' in Carson, *Lost Woods*, p. 90.
[22] Carson, 'Remarks at the Acceptance of the National Book Award for Nonfiction,' p. 91.
[23] Rachel Carson, 'Design for Nature Writing,' in Carson, *Lost Woods*, p. 94.
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[25] Linda Lear, 'Introduction' to part four, in Carson, *Lost Woods*, p. 187.
[26] See, for example, H. Patricia Hynes, 'Ellen Swallow, Lois Gibbs, and Rachel Carson: Catalysts of the American Environmental Movement,' *Women's International Forum* 8 (1985): 291-298; Carolyn Merchant, *Earthcare: Women and the Environment* (New York: Routledge University Press, 1995); Mary Joy Broton, *Women Pioneers for the Environment* (Boston: Northeastern University Press, 1998).
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[28] Lear, *Rachel Carson*, p. 346.
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[31] Ralph H. Lutts, 'Chemical Fallout: Rachel Carson's *Silent Spring*, Radioactive Fallout and the Environmental Movement,' *Environmental Review* 9 (Fall 1985): 214–15, cited in Lear, *Rachel Carson*, pp. 560–561, n. 40.
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[37] Craig Waddell, 'The Reception of *Silent Spring*. An Introduction,' in Waddell, ed., *And No Birds Sing*, p. 9 and n. 3, p.13; Christine Oravec, 'An Inventional Archaeology of "A Fable for Tomorrow,"' in Waddell, ed., *And No Birds Sing*, pp. 42–59 (here p. 43).
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[39] Oravec's study charts Carson's many, thoughtful revisions to the final shape and fictional content of the prologue. Oravec, '*An Inventional Archaeology*.'
[40] June Howard, 'Widening the Dialogue on Feminist Science Fiction,' in Gary Wolfe, ed., *Science Fiction Dialogues* (Chicago: Science Fiction Research Association, 1982), pp. 99. 155–168; Sarah Lefanu, *In the Chinks of the World Machine: Feminism and Science Fiction* (London: The Women's Press, 1988), p. 3.
[41] Joanna Russ, 'What Can a Heroine Do? Or Why Women Can't Write,' in Joanna Russ, *To Write Like a Woman: Essays in Feminism and Science Fiction* (Bloomington and Indianapolis IN: University of Indiana Press, 1995), pp. 79–93 (here p. 81). Russ stakes her claim to the originality of her feminist position when she writes (p. 79) that the essay was originally written in 1971 and published in 1972.
[42] Russ, 'What Can a Heroine Do?' p. 91.
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[47] Harding, *The Science Question in Feminism*, p. 20. See also Nancy Tuana, ed., *Feminism and Science* (Bloomington IN.: University of Indiana Press, 1989). The McCaffrey short story that gave title to the book first appeared in 1961, in *The Magazine of Fantasy and Science Fiction*.
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[49] Haraway, *Primate Visions*, p. 4.
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Re-visioning Science Education

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Abstract

Science education is crucial for shaping the culture of science and its practitioners. Boundaries currently limit ties between natural and social science education structures, exposing the public to a one-dimensional science and its possible ramifications. Believing this to be a "crisis," I explore a variety of approaches to re-visioning science education and the ensuing forms of resistance that these face. In addition, a more personal accounting of my experience with trying to integrate social and cultural issues into the education of scientists allows me to explore the forms of resistance I faced; bridge the gap between theory and practice; and locate more effective ways of re-visioning science education.

Key Words: science education, interdisciplinarity, resistance

Introduction:

In *The Structures of Scientific Revolution* (1962, 1970), Thomas Kuhn set the stage for many social studies and feminist analyses of science (Keller 1998) which question not only the practice of science but also the acculturation of both basic and applied scientists. His classic exploration of the growth of science demonstrated how science should progress and change as new findings and discoveries are made in any field of science that affects one's own subdiscipline. This might be considered analogous to adaptations within and between populations, considered community interactions, which allow them to survive rather than perish. At present, the scientific community does not appear to be "self-correcting" as Kuhn claimed a community in crisis would be. While much of the science community does not see a crisis, feminists, among others, have; and, they have actively examined the nature and culture of science in an effort to resolve this crisis. Critics of science argue that the "objective" and "value-free" structure that science claims, and which Kuhn acknowledges must be present, is far from objective and value-free. Moreover, many feminist scholars proclaim that normalized masculine rationality and exclusionary practices within science serve to reinforce the hidden dimensions of science communities that lack objectivity and value-neutrality (Harding 1991; Keller 1985).

Parallel to these epistemological critiques are questions about the nature of science education. Whom do we teach? What do we teach? How do we teach? Recently, science professionals—19 men, 1 woman—focused on how to prepare graduate students for specific employment opportunities outside of academia, but masked the importance of these very fundamental questions (Committee on Science, Engineering and Public Policy 1995—CSEPP). Similarly, many students never consider that the process of conducting research (What do we study? How do we study it?) is a uniquely human experience that can have very clear political motives.

In contrast to the CSEPP, the National Research Council (NRC) and the National Science Foundation (NSF) have questioned science education. In particular, they have called for broader training and a greater balance between research and teaching for scientists in an effort to "democratize" science (Barr & Birke 1998; Bloom 1997; Petersen 1996). According to Barr and

Birke (1998), such a democratization of science means awakening the scientific community to its own context-bound assumptions and values (e.g., white, heterosexual, masculine, capitalist), hoping to challenge and expand what is accepted and taught as "science."

Science education is crucial to shaping, and possibly reconfiguring, the culture of science and its practitioners. Currently, science education is centered on the learning of facts, theories and procedures that are "…separated from conceptual understandings and decontextualized from their social, historical, cultural and political contexts." (Barton, 1998:13). Moreover, scientific knowledge is developed, and taught, within a positivist tradition where conventional relationships between teacher and student, and between scientist and non-scientist, are built using hierarchical power structures. Students also experience science as a culture, i.e. norms, beliefs, and methods of reasoning and communicating, although they may not recognize the acculturation as fundamentally different from that of other disciplines.

Feminist studies of science education have provided a site for examining the pedagogical features of science education. Some studies focus on developing innovative classroom techniques such as collaborative and participatory learning (Mayberry & Rees 1999). Ultimately, these techniques should provide instructors and students with an appreciation for situated knowledge and learning that values personal experience, encouragement of social understanding and activism, and development of critical thinking and open-mindedness. Although these concepts are familiar in women's studies, science educators are less likely "…to acknowledge [their] potential to transform the traditional conceptualizations of scientific thought that fail to acknowledge the role of culture in the production, dissemination, and utilization of scientific knowledge."(Mayberry & Rees 1997). Incorporating cultural and historical context into natural science curricula, preferably into the core courses, would clearly alter the education of natural scientists.

Thus, there is a need to re-vision the boundaries that currently preclude ties between natural and social science education, where constructivist practices are more widely accepted. Re-visioning involves creating interfaces that are more fluid, questioning the practices that maintain the boundaries, and allowing individuals to engage in interdisciplinary work that is valued rather than marginalized. However, such re-visioning often faces strong resistance from within the scientific and, indeed, the academic community. The resistance is partly a response to change and to the unknown, since most scientists are specialists in their (sub)disciplines whose authority is difficult to question. Interdisciplinary programs (e.g. environmental studies) are seen as "less rigorous" rather than more challenging and are typically undermined by scientists. Finally, there is also resistance to considering science as exclusionary because scientists argue that it is objective and that identity plays no role.

In this paper, I explore the boundaries between natural and social science education by analyzing both the forms and processes of resistance I have observed from within my institution. This manuscript is a theoretical argument, complemented by personal experience from two different disciplines (biology and women's studies), that lends insight that might help to change science education.

This work begins with a brief statement about what science students and professionals have had to say about science education. Within this section I address the notion of scientific method as objective and truth-producing. Next, I focus on resistance to change in science education and examine the ways in which the status quo has been maintained. Finally, I present my experience with crossing disciplines and, in keeping with a feminist perspective, include these experiences as

data to support the theoretical statements.

Breaking Down Myths of Scientific Objectivity and Truth

> Science content must be embedded in a variety of curriculum patterns that are developmentally appropriate, interesting, and relevant to students' lives (National Research Council, National Science Education Standards, 1996: 212).

The training and education of natural and applied scientists, doctors and engineers, has come under intense scrutiny in recent years. One concern is that pre-college teachers are not training students in science courses to think, but rather to accept the authority of a text. Another concern is the high attrition rates of science majors. Fueled by negative experiences in freshman college science courses, 54% of science and engineering majors surveyed said they chose to pursue another field of study (Seymour & Hewitt 1994). In particular, they noted that negative pedagogical and peer group experiences were important influences in their decision to switch to another major. One Hispanic male "switcher" summed up his thoughts this way:

> There's no room for discussion or theory. You just take notes and this is the way something is. There are no different viewpoints.... I found the lack of any kind of human quality very boring (Seymour & Hewitt 1994: 250).

Students in Seymour and Hewitt's confidential survey have not been the only students to express their frustrations. Biology students at the University of California at San Francisco have verbalized their angst over their education, which they have called "one-dimensional" (Bloom 1997: 907). While some students are aware of problems with their science education, many are not. For every student who complains about and/or leaves the sciences, many remain and become indoctrinated into a science culture that is largely operated under a (mis)guided sense of cultural objectivity and absolute fact. This indoctrination produces among its members a sense of superiority and elitism based on the general perception that objective fact-finding and knowledge production reveals truth (often with a capital T). Belief in this "Truth," tends to rule out alternatives and often alternatives cannot even be envisioned.

In the case of science education, "Truth" production can omit or marginalize issues and individuals who may not fit within the norms of what should be included in a science course and how this information should be presented. Omission or marginalization results in issues and people being left unaccounted for within science. Additionally, specialists are taught to remember facts, but often not educated on how their actions affect other organisms, including people. In what may seem to be an extreme example, natural scientists and physicians often create information about groups of people in the absence of social awareness and, historically, this has fueled social problems related to race, class and gender. As a case in point, Cuvier, Darwin, and Lyell, all leading natural scientists of the nineteenth century, were instrumental in shaping the ways that human "norms" were established. Normalizing and upholding some characteristics as superior (e.g., whiteness, masculinity) made it possible to place certain groups of people in other, subordinate categories based on culturally constructed identities of race, class and gender. However, the constructions were promoted and accepted as scientific fact because of who the founders were and not necessarily because of the

accuracy (or adequacy) of the constructs.

If social problems and inadequate health care result from a one-dimensional structure of science education, and the NSF and NRC have called for change, how has the issue been addressed within higher education? In the academy, where we pride ourselves in being open-minded, we may only be reinforcing the problem. Academic institutions, by and large, perpetuate cultural myths. Institutionally, we assign authority in a hierarchical manner where moving up the ranks of authority necessitates our passing through a variety of tunnels that are—structurally, categorically and culturally—easier for some than for others. Additionally, we uphold a strict patriarchal model when we teach in classrooms with seats bolted in place and students facing "the podium of knowledge." This type of classroom makes pedagogical change such as student-centered discussions, instead of lectures that are mostly authoritative, very difficult if not nearly impossible.

Moreover, a hierarchical ordering of disciplines is maintained, with the "real" and "hard" sciences at the top and all else falling short to one degree or another. Evidence for this can be viewed on nearly any college or university campus, most noticeably in the greater space, budgets, salaries, and overall resources allocated to the natural sciences than to other disciplines. Furthermore, most "outstanding" universities are judged so because of their scholarship, which is measured by the number and dollar amounts of research grants held and most grants and dollar amounts secured come through the natural sciences. Additionally, most of these grants come from outside the academy, suggesting how strongly the public and private sectors support science. Grants are available for faculty in the non-natural sciences, but these grants are generally fewer in number with values significantly lower than what natural scientists receive. These very real economic disparities serve to accommodate the "...cultural authority of scientific knowledge and the political autonomy of science" (Lafollette 1998: 7). The perceived superiority of science is also evident from the perspective of students, many of who resist taking natural science courses (because they are too hard) or assume that social science classes are easy because social science is just opinion and a bunch of ideas.

The structure of the academy also encourages science faculty to view students as coming from particular age, race, and class backgrounds. Many have likely generated lecture and classroom materials based on the presumed white, middle-class, and male student body and, when confronted with difference in the classroom, continue to teach in the same way despite evidence that learning is more meaningful in constructivist, rather than positivist, environments (Mintzes et al. 1998). When the classroom diversifies and we have not adapted our teaching materials to relate to this diversification, those students who are "different" from the mainstream will likely suffer academically. Thus, we help perpetuate the hegemonic, scientific order of the academy.

Challenging Science Education: Envisioning Change

Many of the "norms" of the academy have been, and continue to be, challenged and changed for a host of reasons and in a variety of ways. Traditional meanings affiliated with academia, including a hierarchically rigid ladder of authority, have been contested as a result of a more diverse faculty (US Department of Education 2003). For example, the identity of "the professor" is shifting from those features associated with traditional white, male norms as more women and people of color receive doctoral degrees and join faculties. Additionally, more "non-traditional" students are seeking degrees, transforming campuses and classrooms into spaces that contain a wide variety of cultures, experiences, beliefs and practices that exist across the globe. This diversification, among

faculty and student populations, will continue as so-called "minorities" begin to claim a numerical majority of the U.S. population. Finally, new technology has led to physical changes within academia. Classes are more like commodities as students can register for courses offered on one campus but attend the class from another, courtesy of a live video feed. Other changes that have, in part, resulted from advances in technology include WEB-based courses and courses on tape or video, which are multiplying at an amazing rate.

Many faculty and administrators support and encourage such changes as simply a response to the "natural" processes of diversification. However, the culture of science, including the education of scientists, has not always embraced diversity. Some feminists envision a less hierarchical, patriarchal and exclusionary model for science and science education, yet they do not always agree on the "cure" (Barton 1998; Haraway 1997; Harding 1991; Longino 1996; Rosser 1997; Shepherd 1993). For example, Shepherd (1993) proposes that science would become less biased if we appreciated female and male ways of describing and knowing the natural and social worlds around us. In turn, she believes that this would encourage more women and people of color to enter the sciences. Others have maintained that the model of modern science itself is problematic and that simply changing the composition of the scientists is not enough (Harding 1998; Keller 1985; Longino 1996). These scholars argue that we must address the social and cultural issues that exclude groups of people from these disciplines, thus, going beyond Shepherd's dichotomous model of how women and men think differently. Without such an investigation, they claim that change in the institution of science or the academy will never occur.

Although these are primarily theoretical answers, other feminist scholars have taken an applied stand to integrating social and cultural issues in science classes (Mayberry & Rees 1999; Rosser 1995).

Alternatively, we can attempt to draw natural scientists to the courses where they will be encouraged to think about social and cultural issues in relation to science. Entire programs, such as Science and Technology Studies (STS) have been created and are designed to promote and formalize interdisciplinarity. Although these programs provide some students insight into the social and cultural construction of science, it is unlikely that all science majors are required to take courses offered through these programs. Therefore, while a subset of students who are focused on receiving a Bachelor of Science degree will attain some awareness of the relationships between science and culture, the majority of scientists will remain in their disciplines of physics, biology and chemistry. In practice, however, this structuring marginalizes STS by placing them outside of the core science requirements. This further undermines the message and intent of interdisciplinarity.

Above and beyond the difficulty of capturing science students in STS courses, I question the degree to which interdisciplinarity truly exists within STS and similar programs. The courses that make up the curriculum in many of these programs come from a variety of disciplines so perhaps they are, in reality, multidisciplinary. In order to be more interdisciplinary, one faculty might attempt to teach the same topic from multiple perspectives rather than from a single perspective. Such an approach can be risky. It requires leaving the comforts of our well-educated disciplinary perspectives to engage in new ways of thinking about and critiquing issues, including our own disciplines.

I have personal experience with this approach, hoping that my class entitled Women and Science (see below), will engage both natural science and social science students. It is offered as an "exit" course within the General Education requirements, so that students outside of Women's Studies (home to the instructor and course) can receive credit toward their degree, even if not toward

their specific major. Exit courses are at a premium at my campus, so the course is appealing to students from a variety of majors although science majors tend to want a course on women in science - the distinction is important and will be addressed in the section about the course. Although students report that the class changes their perception of science, this approach has limited potential to affect science majors because the course is offered only once a year and is capped at 35-40 students.

Classes and programs can be sites for interdisciplinary approaches but collaborative research can also cross disciplines. Unfortunately, more often than not it is multidisciplinary and accomplished by faculty functioning within their own disciplines and bringing a piece to the whole project without necessarily knowing how their piece fits -- other than in an additive sense. However, just like living systems, such as human bodies, simply adding together the basic parts (i.e., cells) without integration produces nothing functional. That only is achieved by work that is collaborative and relational, by blending together several different perspectives (feminist, scientific and pedagogical), requiring an interdisciplinary analysis of the ways in which culture can be brought to the natural sciences.

While there is support for interdisciplinary work that brings disciplines together, there is also a powerful force of resistance that comes from multiple locations. Like many, I advocate for an interdisciplinary, inclusive and challenging atmosphere in academia. However, the reality of promoting such an atmosphere suggests that many oppose these changes, which leads to a few basic questions. First, why is it that universities are places where such enormous resistance to change occurs? Second, where does the resistance come from; what enables it? Third, how can we promote such change, more effectively, in ways that will be obvious to students, faculty and administrators? In order to address these questions, I consider the avenues through which resistance occurs.

Resisting Change: Maintaining the Status Quo

The Academy includes a group of sub-disciplines, in both the natural and social sciences, which have traditionally been dominated by (white, heterosexual) men and by a patriarchal model for research and knowledge production. The scientific method, as it is called, produces "objective" knowledge with its systematic collection and analysis of data. This "objective" style of research confers a great deal of legitimacy, respect and power to those who employ it (e.g., practitioners of science). Indeed, the presumed objectivity of the scientific method can empower scientists and practitioners with grand support from the general population, such that any perceived threats of change are easily discarded. It has been demonstrated, however, that science does not necessitate objectivity, as the following shows.

Leading 19th century physician and craniologist Samuel Morton hypothesized that the skulls of white males were larger than the skulls of women and people of color. He then proposed, with no scientific justification, that the larger the skull the higher the intelligence. Thus, positive findings would demonstrate that whites were more intelligent than non-white. To "test" his hypothesis, which he ultimately confirmed, he "scientifically" and "systematically" measured the volumes of skulls from numerous races. Several years later, a scholar was studying Morton's work and discovered some problems with the raw data— all of which was published. While Morton's work was believed to be scientific, and therefore unbiased, he had actually misrepresented many races within the study. His Native American sample contained a disproportionately high number of smaller skulls while the Iroquois, who had larger skulls, were grossly under-represented. Furthermore, he included only

three Hindu skulls in the sample of white skulls. Many more were available to him but all of the Hindu skulls were extremely small and would have lowered the overall score for the population of white skulls (Gould 1981). In other words, in order to prove his hypothesis, he manipulated the study and the data, a clear use of his subjective will.

Despite the revelation of similarly biased studies (Fausto-Sterling 1995; Tavris 1992), many have actively fought to maintain the current scientific model. Whether conscious or not, many of these resistors engage in a process of "Othering" (Fine 1993; hooks 1990). This process leads those in dominant positions to speak of Others as somehow deficient or fatally flawed. Figuratively and literally, the Others are pushed to the margins and homogenized in ways that allow differences within the marginalized group to be disregarded. At times, this speech even "annihilates, [or] erases" while creating and defining the Other in ways that reinforce and substantiate those in positions of dominance (Hall 1991; hooks 1990: 151). Regardless of the precise configuration it assumes, Othering preserves a system of domination and submission by marking the Other as separate from and inferior to those deemed "normal."

An example of Othering within science communities involves the preservation of a hierarchical ranking or model of its practitioners. For example, women who choose to become scientists are often viewed with suspicion and are often constructed as Others who are "naturally" different from men. This difference, some would say, makes women less capable in the science world. Women are often perceived to be "less serious" scholars than men because they have a womb, which can be defined as a "natural," female distraction that might/will pull them away from their "real," science work.

Also, women have been perceived to be less knowledgeable, rendering them open to more challenges (than men) by both women and men students (Kierstead, D'Agostino & Dill 1988). Additionally, women's research has been evaluated with more cynicism than articles by men have been. In fact, fewer papers are accepted for publication, and fewer and smaller grants are awarded to women researchers. Ironically, science articles published by women have a greater citation rate -- 24.4 per paper versus 14.4 for the men (Holden 1996).

Finally, women who choose to question and examine the scientific culture are Othered in a myriad of ways. For example, women who choose to teach science by adding "social" elements to the topic, and who are willing to talk about it, are criticized for including material that is "not related to science." Thus, these women are highlighted and defined as inferior scientists, and often hear about it when it comes time to be evaluated another. Rather than being commended for exploring the all-too-real connection between science and society, these scientists are marginalized (Fausto-Sterling 1997). Often, women who critique tradition science leave their discipline of choice and join other groups. While these alternative homes may be more open to new ways of doing science, traditional science communities also marginalize them. In turn, this reduces the scientists within these communities to an inferior status.

In these claims, and countless others like them, women are evaluated based on "biological destiny," and on their "naturally inferior mental abilities." In the face of such adversity and its cumulative impact on women (Schiebinger 1999; Wilson 1995) some have argued that we are asking the wrong question. Rather than asking why there are so few women in the natural sciences in specific, and academia in general, we should be asking how there can be any at all. As indicated earlier, many people who recognize the problems with science often leave, suggesting that science is less examined/critiqued and further isolated. And the question remains unanswered; how can the

rigid boundaries between the social and natural sciences be re-visioned?

In order to address this question, I turn to my own experiences with attempting to blur the boundaries of academic disciplines. Each experience reveals a host of different settings and players who resist this blurring in multiple ways. By presenting these experiences, we move beyond the purely theoretical critiques of science, though I use this theory as a foundation for our analysis.

There are two goals in sharing and analyzing these experiences. First, the very recounting of them brings this "problem" into a more vocal and visible light -- for non-scientists and scientists. Like others, I recognize why it is important that we are part of our research and why our stories need to be heard (Mayberry, Subramaniam & Weasel 2001). Hopefully, these stories will compel others to share their stories as well. Second, a systemic analysis of these experiences will yield more complete knowledge of situations that facilitate ways that knowing are "regarded" within science communities. For example, what forms of resistance were encountered? Who and what supports and/or performs resistance to this effort? How do we respond to acts of resistance, and can we learn from our reactions if better responses might yield better results?

~~Women In~~ Women and Science

What does it mean to be "outside the discipline"? It may not always be clear, but once an individual even thinks of venturing outside the lines, they hear sounds of alarm. Earning and maintaining insider status is vital to a scientist's progress, so the alarms suggest. Even undergraduate science majors learn this lesson quickly.

I was no stranger to this lesson. As an undergraduate studying biology, it was clear that I had to take as many biology, or other science, courses as possible and should not waste time with other subjects. However, in addition to my major, I also minored in Environmental Studies where I was required to complete one social science class. I chose cultural anthropology and can remember, very vividly, my beliefs about that course; it was a course I could and did skip. It was not a course, I reasoned with the assistance of internalized scientific culture, like my biology courses. We discussed topics and did more reading in the anthropology class. On the contrary, I felt that if I missed a biology course, I would have missed "critical information," since professors told us what we should know and read. I never questioned this belief or practice and it is one that persists among biology students today.

Despite my own entry into the scientific culture, I now find it difficult to teach science students with the ethos I had as an undergraduate. As a faculty member in Women's Studies and environmental studies, I am visibly outside the bounds of real science. So when I do teach young scientists, they often come to class with the same mentality I had for that anthropology course. In a course in which I repeatedly draw connections between biology, technology and society, science majors' (generally 80-90% of my students) comments on course evaluations clearly demonstrate their beliefs. One particularly poignant comment provided anonymously by a student reads:

> (She) keeps repeating that we should be more concerned with learning than with our grades-yeah, right--this is a social science class--contrary to popular belief, this class is not important. We took this class to get a good grade--we can learn when we're taking real classes, chemistry, biology, mathematics, not this stuff.

Without a doubt, this undergraduate, and others like her/him, had already been cleanly and crisply

indoctrinated into the culture of science. The faculty within this department, and the department itself, fostered this sort of mentality, as one recent experience clearly demonstrates.

Several years ago, I taught a course entitled Women and Science at the request of the biology department. The registered science students reported that they believed they were going to learn about famous women in science, rather than women and science, and that had compelled them to take the course. This came as little surprise since the biology department had advertised the course with flyers proclaiming a new course that would teach them about the famous women in science. By advertising it as women in science, they were telling students that there is no discrepancy, bias or discrimination within the natural sciences; only important players, some of whom were women. Other departments, such as chemistry, offer courses that focus on the participants in chemistry using a historical perspective (although students report that no women are included).

My first class, offered through biology, was composed almost entirely of women who were majoring in biology and even today it is primarily women who enroll in the class. The current situation is not surprising since the course is now offered through the department of Women's Studies where men tend not to venture. In effect, by keeping the course in Women's Studies rather than integrating it into the undergraduate science curriculum, the departments of natural science support the course only as an illegitimate one.

When the course was offered as a biology course, one male faculty member inquired "why do we need a course about women in science?" Experience suggests that if one individual asked the question, others were surely thinking it. This type of resistance to inclusion of "other" materials (e.g., women in science courses; sexuality, culture, race/ethnicity in medical training) is common, and yet seldom occurs in the reverse manner. For example, faculty members do not contest the fact that animal behavior is taught in biology rather than psychology. Science has claimed a domain and departments help preserve this domain as untouchable.

Undergraduate science majors emulate the department's divide and conquer mission. Students express, in their own ways, resistance to courses not "scientific" enough for them. While they may not have verbalized possible hesitations, let alone resistance, to learn about biases or inequities in science and technology, they were capable of expressing that their interest was only in learning about those famous women who made it in science (emphasis added). On the first day of the course, I always ask students to write down what they hope to learn in the class. Almost all want to learn about women scientists.

Discussion

Systemically, requirements for natural science programs are almost completely structured, and often consume nearly all of a student's educational time. Whether a student is consumed by her/his chemistry requirements—courses, labs, etc.—or by rigidly prescribed courses and clinical work in medical school, the results are the same. This structuring leaves little, if any time for material outside the discipline. Moreover, supremacy and overall virtue of their own discipline becomes clear when most/all of a student's study is housed within the discipline; courses outside are not required, and sometimes not encouraged, thus they are unimportant. Content from non-science courses is seldom, if ever, incorporated into the discipline's testing regime.

Natural science education programs promote a goal-oriented focus, which ultimately separates science disciplines from others that might use another model (e.g., inquiry based). A goal-oriented focus has students concentrate on individual goals as being central to long-term goals. So,

if a student wants to be a scientist, s/he identifies the individual goals that must be accomplished. While I appreciate the importance of goal-orientation, such a focus has limitations with serious consequences for the populace. Clearly, the most important limitation involves a learned culture that fails to incorporate a social and human aspect of the world within the world of science and of scientists. Additionally, this structure virtually excludes non-science students from taking a science course. An "us-versus-them" mentality ultimately results.

It is clear that structures contribute to separating and ranking of disciplines. Interpersonal actions, such as socialization, also factor into this schism. For example, the faculty plays a key role in socializing our future scientists, engineers and doctors, often teaching the students how to exclude those "deemed" inappropriate. Whether or not the resulting separation of disciplines is a conscious goal is not the issue. The fact that this is the outcome is what seems important. Furthermore, by structuring major requirements that exclude the courses taught outside the natural sciences, departments and their members relegated non-science work as unacceptable. Structuring acceptable courses for majors takes place in all disciplines and is not limited to the natural sciences. In effect, the procedure not only defines a field by revealing what is and is not part of the discipline, but also excludes and marginalizes "others" by outlining how they differ from what is accepted. Evidently, the process of normalizing separation is relational, and involves interaction between individuals and institutions. This process simply validates and strengthens a system that literally separates disciplines and secures boundaries that keep them apart. Thus, goal-orientation is empowered, as is the "understanding" of what is important. Again, the problems arise out of and are maintained by both systemic and interpersonal arenas, and through their interactions with one another.

Given my, and others, attempts at bringing social and cultural issues to the sciences leaves me with serious concerns about the intense socialization of students into a science-only ethos. Science students are led to internalize a rigid culture where science is omnipotent. By the time we encounter them in a social science elective or exit course, we are seen and treated as the "other." In fact, if they take our classes and run into intense reading and writing loads, students make it all too clear that they do not have the time for this, especially in a non-science course. Even at the post-graduate level, for example where students are in medical training, learning about people who they will likely face in a physician's office strikes many doctors-in-training as unimportant; especially when they learn from peers that this material is not covered on their annual examination.

If problems occur at both the structural and interpersonal levels, then we must look for resolutions at both levels. For example, one of the best methods of re-visioning the disciplines involves incorporation of difference within our courses; and not by means of bringing in an "other" for the occasional, special guest lecture. Instead why not re-vision an educational system where breadth of knowledge, on the part of both the instructor and the student, is valued? This is not to suggest that specialization is no longer necessary. However, the professor of a given science course ought to be able and willing to present basic social and cultural issues, just as a social science professor ought to be able to give fundamental chemical or biological perspectives if relevant. Unfortunately, most are probably reluctant to engage in this type of cross-disciplinary teaching, especially if they feel ill equipped to do so, or if they receive little recognition or credit for doing this. Additionally, there is really no incentive, currently, for faculty to learn the material -- we are already successful in a system that rewards specialization and not breadth of knowledge. Some incentive at the structural level must be established in order to encourage faculty to seek further training. Neither structural incentives nor one faculty changing a course can create change on its

own.

This analysis and the suggestions for change are predicated on the idea that science education focuses on "the development of the ability to think" (Bybee 1993:86). What seems dissonant is the current notion that science students can be trained to think (or recall) an/the answer without integrating social and scientific contexts.

Additionally, this evaluation rests with Thomas Kuhn's (1962/70) belief that "mature science" withstands "scientific revolutions" by transforming paradigms. Kuhn argued that most, if not all, revolutions occur as a result of some crisis. In his context as well as mine, crisis refers to progress, contestation, inventions, or even proof that an old paradigm is no longer sufficient. These crises may be generated within a scientific community that ultimately goes through revolutionary changes. Or, a discovery in chemistry, and maybe even political science, might generate a crisis in a third department where economics or globalization are taught. Regardless of the origins, a crisis "suppl[ies].... a self-correcting mechanism which ensures that the rigidity of normal science will not forever go unchallenged" (Kuhn 1970: 181).

Today academics work within fairly isolated arenas, and perhaps we do so out of a fear of challenge. Fundamentally, this isolation is our modern crisis, and it is time for change, especially in science education where both thought models, inquiry based and goal orientation, must be integrated. Incorporating an inquiry-based model with the goal-orientation model would train more science and medical students to consider how their trade impacts, both positively and negatively, the world around them. An incorporated model will produce new perspectives and methods that lead to changes in models, experimental subjects and interpretation of data.

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Preface to Poems

By Catherine Daly[i]

Marguerite Porete was executed as a heretic in France in the early 1300s. Her book, *Le Mirouer Des Simples Ames Anienties Et Qui Seulement Demourent En Vouloir Et Desir D'Amour*, has been the source of three recent writing projects. The second act of Anne Carson's opera libretto entitled DECREATION is based on Porete's trial testimony and writing. MD Coverley edited an online project where concerns that Porete and net.artists share are debated, THE MIRROR OF SIMPLE ANNIHILATED SOULS (at http://currents.cwrl.utexas.edu/archives/fall01/fall01/luesebrink/wone.htm). "In Medias Res," a contemporaneous long poem excerpted here, but also existing in animated MS PowerPoint and transparency, approaches this morality play through "lo fi" and ubiquitous technology (that of common office software) to demonstrate writing's survival and erasure. Slide transitions and some transitions which are only available in certain mediums (named in the poem's section titles) fade the text to white. The words form transitional poems before they disappear.

Porete was forced to witness her books' burning before she was burned. Yet, one reason she was a heretic was she distributed her work: In a time when women "were not" peripatetic preachers with self-published books, she was. Many copies of her book survived the *auto da fe*. So, too, her work has become useful to a diverse group of contemporary writers.

In Medias Res

Marguerite Porete / Porette of Hainaut / de Hannonia

Box Out

Humility, Queen of the virtues,
mathematics, Queen of the sciences. When I draw a family,
Pythagoras, Plato, Aristotle, Marcellina,
all wear five point crowns
five digits in each hand and
e can flowers without time's thorns, defused and I crown us all,
regle

O emerald, diamond, Queen, Empress, knowledge no riches but pleasure not awe.

And now a word from our sponsor ...

o, Aristotle, Marcellina
e point crowns
digits in each hand and

crowns

Box In

Cattle live by silage.
corn
Live by look kernel seed
core

i.e., by free will, servants of the law.

kernel translates physical I/O to logical I/O
2038

allocate
allocute

Many of these slides lack focal points ((focus)).

corn
look kernel seed
core

Wipe

O, what will Beguines say when they hear you sing?

Truth declares
I am loved by one.

A	B	A XOR B
0	0	0
0	1	1
1	0	1
1	1	0

This is true, but I would lie as soon as say something.

Begin.
Love talks. She walks in me. I am still. The earth is motionless.
Humming ceases.

Humming ceases.

Dissolve Letters, Bridging to Cover a Break in Time.

It's necessary servers aren't free;
it's possible those sensing aren't dead;
it's ok if who desires, wills;
it's not ok if who wills, begs;
it will always be the case who begs, lacks;
it's de-lovely.

I said *I will love*.
I lie. *He alone loves me*:
he is, I'm not.

t at a e 't ;
s s i e t at se ses d a ;
ok ho , w l s;
o w o i l , be s
w l c se w o egs, a ks;
de- .

I lo e.
I . e l ve me:
i no

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