Women in Science: Racial and Ethnic Differences and the Differences They Make

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ABSTRACT. Often the term "women" is assumed to include women of color in the same way as the terms "African American" and "Hispanic" are assumed to include both women and men. Although women of color and non-Hispanic white women are under represented in the science labor force, the rates of and factors contributing to this under representation differ by race and ethnicity. Consequently, disaggregating data on women in science by race and ethnicity is crucial to capture these differences. Such distinctions are critical to developing effective policy, practice, and programs to increase the participation of women in science.

Key Words: minority women, science, policy

JEL Classifications: J21, C43, J24

1. Introduction

Traditionally, the United States (US) recruited science talent from a pool consisting predominantly of non-Hispanic white middle-class males. Scholarly research documents the under representation[1] of African Americans, Hispanics, Native Americans, Alaskan Native/Pacific Islanders and non-Hispanic white women in terms of doctorates earned, participation in the science (and engineering) workforce in general, and on postsecondary faculties in particular (Harvey, 2002; NSF, 2004b; Nelson, 2005; Quintana-Baker, 2002; Wilson, 2004). Some research goes a step further, and suggests ways to increase the participation of under represented groups in the science workforce (American Association of University Women [AAUW], 2004; BEST, 2004; CEOSE, 2004; Jackson, 2004; MacLachlan, 2004; Malcom *et al.*, 2004).

Research on under representation in science focuses on two major categories: minorities and women. This focus is due in part to the way data on the science workforce have been traditionally collected: by race/ethnicity OR sex, but not by race/ethnicity AND sex. One result of collecting data this way is that "minority women"[2] tend to disappear among aggregates of all women, or all members of a particular ethnic group (MacLachlan, 2000). This both reflects and reinforces the invisibility of minority women in science.

2. Background

Science is often defined as a body of knowledge, and a set of systematic methods and procedures for collecting and organizing information. Science can also be defined as a social enterprise, in at least two ways. First, one of the hallmarks of science is the sharing of information with members of the science community (Merton, 1973). Second, because science is an enterprise in which facts are created by human beings, socialization and group characteristics are important insofar as they influence the values and beliefs of people who become scientists (Hubbard, 2001). However, as Friere (1985) points out, "reality is never just simply the objective datum, the concrete fact, but it is also people's perception of it" (1985, p. 51). Collins (2004) contends that knowledge is shaped not only by gender but also by race. Therefore, who practices science significantly affects research in terms of problem choice, data collection and analysis (Leggon and Malcom, 1994).

Who practices science also affects the dissemination of data and information in terms of format and content. Format refers to whether the data are presented so as to be understandable. Format also refers to how data are presented—and misrepresented—as when, for example, some data are emphasized while other equally important data are downplayed, obscured, or eliminated. This is not a

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trivial point—it can literally be a matter of life and death. For example, in 1997, the *New England Journal of Medicine* published a significant study discrediting the research, publicized by pro-life activists, suggesting a connection between abortion and breast cancer (National Council for Research on Women, 2004).

Race, ethnicity and gender affect how knowledge is formulated, interpreted and perceived; these effects are not additive, but synergistic. Race, ethnicity, and gender are so inextricably intertwined that it is often difficult for women to distinguish one from the other (Leggon, 1980; Turner, 2002). ''Intersectional paradigms view race, class, gender, sexuality, ethnicity, and age...as mutually constructing systems of power or a specific constellation of social practices that show how oppressions converge'' (Collins, 2004, p. 11). In this context, Turner argues that Kanter's (1977) theories regarding tokens in organizations ''imply that the more ways one differs from the 'norm' the more social interactions will be affected within multiple contexts'' (2002, p. 77); therefore, ''the interlocking effects of gender and race compound the pressures of the workplace environment for faculty women of color'' (2002, p. 79).

Women on college and university science faculties are the focal point for this paper because colleges and universities are sites for cutting-edge research that shapes what kind of science will be done in the future. Furthermore, these faculties perform significant gate keeping functions insofar as they train the next generation of scientists and play a major role in encouraging or discouraging students to pursue careers in science. This paper reports the distribution of academic scientists by gender, race and ethnicity, and suggests policy directions for improving representation.

3. Methodology and data

Data collection on the science workforce has been problematic. Traditionally, data were disaggregated by race/ethnicity OR sex. Since the mid-1980s, some scholars called for these data to be disaggregated by race, ethnicity AND sex. This disaggregation has been done by a few scholars, such as Leggon and Pearson (1997), Quintana-Baker (2002), Solorzano (1994), and more recently, the National Science Foundation (NSF) in *Women, Minorities and Persons with Disabilities in Science and Engineering*; however, this practice is neither widespread nor consistent due to the challenge of small numbers and confidentiality. The lack of disaggregated data conceals differences among subgroups which, in turn, precludes an accurate assessment of the participation in science of underrepresented minority women—African American, Mexican American, Native American/Alaskan Native, Native Pacific Islander, and Puerto Rican.

Consequences of aggregated data

Failure to disaggregate data on women by race and ethnicity obscures significant differences among women that can result in policy and practice that are ineffective at best and counterproductive at worst. Moreover, ''inferences drawn from an aggregated over-parity status serve to make invisible the varied needs of a heterogeneous population'' (Turner, 2002, p. 77; Cho, 1996). For example, at the doctoral level between 1966 and 2001, women US citizens and permanent residents as percentages of all degree recipients in science and engineering (S&E) fields almost quadrupled from 10% to 39%. The most dramatic changes between 1992 and 2001 among female doctoral degree recipients occurred in the biological sciences. However, disaggregating data on female doctoral degree recipients by race and ethnicity, reveals increases from 1992 to 2001 for non-Hispanic Blacks (from 2% to 4%), Hispanics (from 3% to 4%), and Asian/Pacific Americans (from 9% to 14%) (Tabulations by *the* N*ational* S*cience* F*oundation* S*cience* R*esources* S*tatistics* from *the* S*urvey of* E*arned* D*octorates* 2001).

Failure to disaggregate race/ethnic data by gender obscures significant gender differences. For example, among African American full time faculty in higher education, men tend to be tenured and hold senior ranks (professor, and associate professor) and women tend to be non-tenured and hold lower ranks—assistant professor, and lecturer (Harvey, 2003). Among both Hispanics and American Indians, men hold the majority of faculty positions in their respective ethnic group.

Sources for reliable datasets and/or series that disaggregate by race/ethnicity AND gender include: the National Science Foundation (NSF); the

American Council on Education (ACE); the National Center for Education Statistics (NCES); and the Commission on Professionals in Science and Technology (CPST). It is important to note that disaggregating data by race/ethnicity and gender has been a gradual process. Although NSF has collected data on graduate science and engineering enrollment and postdoctoral appointees since 1966, racial/ethnic data were first requested in 1979 and became a standard item on the questionnaire in 1980. Race/ethnic data by sex were first requested in 1993, and became a standard item on the questionnaire in 1994 (NSF, 2002a). Also, because the ways in which some categories are defined change over time, comparability among surveys can be problematic. The new government-wide standards for the collection of data on race and ethnicity announced by the US Office of Management and Budget (OMB) in October 1997 did not go into effect January 1, 2003.

Trends in science degrees awarded to women

Bachelor's degree. Each year since 1992, there has been an increase in the number of science bachelor's degrees in the natural sciences awarded to women who are citizens or permanent residents of the US. However, disaggregating the data reveal that between 1992 and 2001 the percentage of bachelor's degrees in the natural sciences awarded to non-Hispanic white women declined from 79% to 70%, while the percentages of bachelor's degrees in the natural sciences awarded to Black non-Hispanic and Hispanic women increased from 6% to 8% and from 5% to 6%, respectively, as shown in Figure 1 (CPST, 2004, Table 2–74).

Unfortunately, increases in the numbers of all women earning BS degrees in the biological and physical sciences have not been reflected in the numbers of science doctoral degrees they earn.

Doctorates. From 1994 to 2003, women who are US citizens or permanent residents earned almost three times as many doctorates in the biological sciences as they earned in the physical sciences, mathematics and computer science (Hoffer *et al.*, 2004; NSF, 2004b, Table 7). Disaggregating these data by race and ethnicity reveals a similar pattern for Black women and non-Hispanic white women who earned between three and four times as many doctorates in the biological sciences as in the physical sciences. Mexican American and Puerto Rican women each earned four times as many doctorates in the biological sciences than in the physical sciences. It is important to note, however, that the numbers of science doctorates awarded to Mexican American and Puerto Rican women in the biological sciences and the physical sciences are small. (Hoffer *et al.*, 2004; NSF, 2004b, Table 7).

Institutional contexts of female scientists

In general, female science doctorate recipients were less likely than males to have earned their bachelor's degree at a research university. All of the

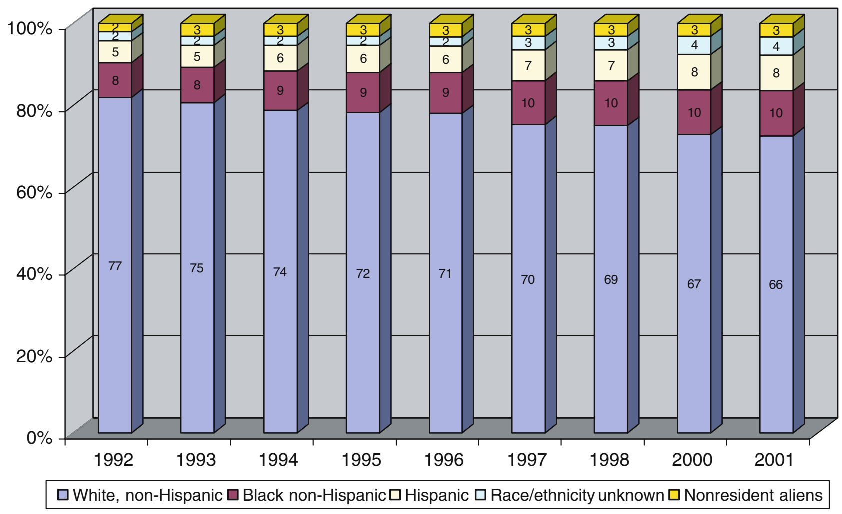

Figure 1. Percentage distribution of science and engineering BS degrees earned by women by race/ethnicity, citizenship and year.

top 50 baccalaureate-origin institutions for males were research institutions (NSF, 2003b, p. 50), but for women only 43 of the top 50 baccalaureate-origin institutions were research institutions. Moreover, females were more likely than males to have their baccalaureate-origin institution in a liberal arts college. In contrast, 5 of the top 50 baccalaureate-origin institutions for females were liberal arts colleges; and 4 of these 5 were predominantly women's colleges—Wellesley, Smith, Mount Holyoke, and Bryn Mawr (NSF, 2003b).

Predominantly women's colleges have also played a major role in producing African American females who earn doctorates in the sciences. For example, 75% of the African American females awarded doctorates in biology between 1975 and 1992 graduated from two women's colleges—Spelman College in Atlanta, GA and Bennett College in Greensboro, NC (Leggon and Pearson, 1997). Spelman College continues to be among the top BS producers of African American women who go on to earn the doctorate. After identifying the baccalaureate origins of doctorate recipients, the next step is to identify factors and elements of the institutional climate that facilitated the production of future Ph.D. recipients. In the case of Spelman College, one major factor was Dr. Etta Falconer, a mathematics professor who worked collaboratively with Shirley McBay, a mathematician, and Dr. Audrey Manley—a physician, US Public Health Officer and Spelman alumna—to acquire resources to enhance the infrastructure and programs in the sciences.

Women on science faculty in US colleges and universities

Representation

Women's gains in representation among those earning baccalaureate and doctoral degrees in science have not been reflected in their representation among college and university faculty. Four times as many men as women with science and engineering doctorates hold full time faculty positions (CPST, 2002). In 2001, among employed persons with science doctorates, a greater percentage of women than men worked in 4-year colleges and universities, state and local government, and were self employed; a greater percentage of men than women worked in the federal government and the private for-profit sector.

Despite the fact that African American women obtain degrees at higher rates than do African American men, African American women comprised less than half of the total African American full-time faculty in US colleges and universities in 2000 (Harvey, 2003; Hamilton, 2002). The under-representation of women on faculties both reflects and reinforces the gender imbalances between the compositions of the student body and faculty, as shown in Table I.

In chemistry, computer science, and physics a greater percentage of males are on the faculty than earn bachelor's degrees; for these fields women comprise a smaller percentage of faculty than of female students earning bachelor's degrees. However, in biology, women comprise 58% of the students earning bachelor's degrees but only 20% of the faculty; men comprise less than half of students earning bachelor's degrees but comprise more than three-fourths of the faculty.

Institutional prestige

There is an inverse correlation between the prestige of an institution and the proportion of female faculty: the more prestigious the institution, the smaller the percentage of women faculty (Wilson, 2004). For example, in 2001, women comprised almost half (48%) of the professoriate at 2-year institutions, more than one-third (38%) at baccalaureate-granting institutions, but little more than one-fourth (28%) at research institutions. This is even more pronounced in the sciences, as Nelson's work (2005) reveals. For FY 2002, women comprised 12.1% of chemistry faculty, 10.6% of computer science faculty, 6.6% of physics faculty, and 20.2% of biology faculty.

Table I
Gender distribution of BS recipients as compared to faculty

	% Female		% Male	
	Students	Faculty	Students	Faculty
Biological sciences	58.4	20.2	41.6	79.8
Chemistry	47.3	12.1	52.7	87.9
Computer science	27.7	10.6	72.3	89.4
Physics	21.4	6.6	78.6	93.4

Source: NSF, 2002b.

Tenure

Not only are women more likely than men to work at less prestigious institutions, they are also less likely to be tenured (Carnegie Foundation, 1990; Kahn, 1993; Sonnert and Holton, 1995) and more likely to hold lower academic ranks (Long, 2001; Olson, 1999; Ransom and Megdal, 1993). Women comprised 10% of all full professors in 1980 and 24% in 2000; similarly, they comprised 21% of all associate professors in 1980 and 39% in 2000 (Harvey, 2002). Although the proportion of men across all ranks decreased between 1980 and 2000, men still occupy the majority of positions at the levels of full professor and associate professor (Harvey, 2002). During the 1990s, women were responsible for the increases in the numbers of faculty positions held by both African Americans and Hispanics. Nevertheless, African American and Hispanic males still held the majority of faculty positions (Harvey, 2003).

Under-represented minority women are less likely than either non-Hispanic white women or men of any racial group to be awarded tenure. Again, this is more acute in the sciences at the top 50 research institutions. For example, in FY 2002 at the top 50 research institutions in both computer science and physics there were no non-Hispanic Black women or American Indian faculty (Nelson, 2005). Of all race/ethnic groups, African Americans experienced the greatest decrease between 1980 and 2000 in the percentage of full professorships, dropping 11.3% among women and 7.2% among men. Despite the increase in full professorships held by American Indian women, they still comprised only 25 percent of American Indian full professors. Although there was little change in full professorships among Hispanics, there were significant increases in both associate professorships and assistant professorships; however, men still held the majority of faculty positions. Asian Americans (excluding Native Americans) were the only group with growth in full professorships. However, 70% of all faculty positions held by Asian Americans were held by Asian American men (Harvey, 2003).

Across race/ethnic groups, there are inverse correlations between rank and the percentage of women in that rank; and prestige ranking of institutions and percentages of women on the faculty. Moreover, under represented minority women are less likely than their non-Hispanic white female counterparts and their male race/ethnic counterparts to be awarded tenure and to be full professors (Wilds, 2000).

Compensation

Across disciplines and institutional types and at all ranks, female faculty members earn lower salaries than men do (NSF, 2003b), and this disparity increases with rank—that is, the higher the rank the greater the salary disparity. In many cases, this disparity is due to the fact that women tend not to negotiate salary, while men do. One major factor contributing to this difference is mentoring. As graduate students, men's mentors socialize them into the profession, teach them how academe operates and that not only is negotiation possible, it is expected. Although mentoring in graduate school is critical to career development, it seems to be problematic for women, as one African American female educator describes: "the academy is not good at nurturing their young—they eat their young" (Hamilton, 2002).

Not only are women less likely than men to negotiate salary, they are also less likely to negotiate other conditions of employment such as number of courses taught and number of students per course; number of undergraduate and graduate students advised; number and level of committee work; graduate student teaching and research assistants; laboratory space and equipment; and travel funds (MIT Report, 2002; Turner, 2002). Women, in general, and under represented minority women, in particular, often lack such mentors and are at a disadvantage compared to non-Hispanic white men in terms of such major career decisions as: choosing a graduate institution; identifying faculty to serve as references; publishing as a graduate student; choosing a postdoc; developing a research agenda; learning the formal and informal rules of tenure and promotion; obtaining information on grants; establishing collaborations; and identifying appropriate publications for their work (MIT Report, 2002).

Men's advantages and women's disadvantages are cumulative. Unless across-the-board adjustments are made, women faculty can never "catch up" to their male counterparts. In sum, not only are women, in general, and under represented minority women, in particular, at a disadvantage compared to men in terms of access to information relating to major career decisions, some women do not know that they do not know these things.

Implications for policy, practice and programs

Women (as well as men of color) experience social isolation, bias and hostility, and an unwelcoming environment in academe (MIT Report, 2002; Turner, 2002). The under representation of women sends the wrong message to all students: that women do not or cannot belong to the academic science community (CEOSE, 2004; Margolis and Fisher, 2002). What accounts for that under representation? One factor is that women self-select out of academic research careers because they encounter few female faculty members and they see the difficulties of earning tenure and promotion of the few female professors whom they do encounter. In higher education, women are under-represented in leadership positions on faculties and in administration, and lack the critical mass necessary to reduce barriers to institutional change (CEOSE, 2004; Etzkowitz *et al*., 2000).

Changing academe is a political process. MacLachlan (2004) asserts that implementing institutional change in academe requires first and foremost developing an understanding of the issues and problems. There is nothing Byzantine about women's under-representation on science faculties. Data on the demographic composition of science talent pools disaggregated by race/ethnicity and gender document the participation of various groups in the US science labor force. Frameworks for analyzing these data can be obtained from research literatures in sociology, race and ethnic studies, and women's studies.

Equally important is to review the "best" or most effective practices to increase representation and diversity in the sciences to identify principles and tailor them to a particular institution. In addition, identifying the "worst" or least effective practices may also be instructive. Although research has already yielded information on how to increase access to STEM fields, these findings have been neither sufficiently disseminated nor fully integrated into the planning of new programs and the evaluation of existing programs (NSF, 2005). Such higher education design principles are presented in BEST (2004) and in the final NSF workshop report on pathways to STEM careers (NSF, 2005).

Trower and Chait (2003) argue the lack of diversity of science faculties is less the result of tenure as an institution and more that of tenure in its implementation. Tenure processes and practices need to be re-examined in the context of maximizing faculty diversity. Specific sources of dissatisfaction with the tenure process that have been identified include: ambiguous standards; contradictory priorities and expectations; erratic feedback; and inconsistent and incomplete performance reviews (MacLachlan, 2004). Tenure policies and practices must be transparent and clearly communicated in writing; any changes in the tenure process and the extent to which an individual is affected must also be clearly communicated in writing.

Changes in hiring, tenure and promotion procedures should be made at all levels—from the department to the division, and higher. For example, since hiring begins at the department level, it is incumbent on departments to take the lead in examining each and every aspect of the hiring process (National Science Board, 2004). Concerted efforts should be made to cast the net wider and stop recruiting all of the "usual candidates" from the usual places.

Colleges and universities should identify existing programs that focus on increasing participation in STEM fields and explore ways in which the programs can work together. For example, the evaluation team of the Leadership Alliance[3], (2004) found that some summer research sites integrated the program into their institutional structure and used it as a pool from which to recruit under represented minority graduate students.

Having policies, programs and practices that are data driven and results oriented is consistent with science's fundamental principles of empirical research and disclosure of results. To achieve this, faculty from departments of biological, physical, and computer sciences should work with their colleagues in the social sciences, women's studies, and ethnic/minority studies to devise processes and procedures to increase the representation of under represented groups on the faculty. When examining issues of faculty composition faculty in the biological, physical and computer sciences all too often overlook their colleagues in the social sciences and in women's studies who have both the expertise and experience in scientifically designing, implementing, and evaluating policies and programs.

Policy, program, and practices to increase representation of women in general and underrepresented minority women in particular must not be piecemeal and scattered; they must be coherent and cohesive (AAUW, 2004; BEST, 2004). While change is often brought about by the efforts of a few dedicated individuals, change can only be sustained by becoming an integral part of the standard operating procedures of a college or university. Programs must be constantly and consistently monitored to provide feedback to faculty and administrators so that real time corrections can be made when warranted (AAUW, 2004). Accountability is essential in implementing and institutionalizing change. The extent to which efforts succeed in diversifying the faculty should be one of the criteria on which the performance of department chairs and administrators is evaluated; data collection is essential to provide the metrics by which this performance can be measured.

Data collection is also crucial to assess equity projects in the sciences. The CEOSE Decennial Report to the US Congress, (2004) discusses the need to continue "to obtain, refine, and disaggregate data and factors related to the participation and advancement of persons from under represented groups in science, technology, engineering, and mathematics education and careers." A similar position is taken by the American Association of University Women, "data on gender alone is not enough. Information on racial and ethnic groups and groups by disability and socioeconomic and immigrant status would greatly improve knowledge of who projects are serving and affecting" (AAUW, 2004). Yet, the small numbers give rise to issues of confidentiality. Some researchers argue that confidentiality is not a real issue, because the numbers in each under represented group are so small (especially when disaggregated by race/ethnicity, gender and field) that everyone knows who these people are. Should this preclude collecting data on groups that are under represented in the science workforce? Can such data be collected by surveying the entire universe of each under represented group? This may be possible using surveys. What about the issue of confidentiality in collecting longitudinal data on career pathways? My research and evaluation activities indicate that some members of under represented groups are willing to have their career pathways and experiences studied because, as one focus group participant said, "I am glad that someone is interested my career and the issues that interest me." Others have said that they are willing to participate in studies of career pathways so that those who come after them can learn from their career experiences.

Notes

1. A group is "under represented" if the percentage it comprises of the science work force is less than the percentage it comprises of the US population.
2. The term "minority women" refers to African American, Hispanic, American Indian/Alaskan Native, and Asian/Pacific Islander.
3. The Leadership Alliance is a consortium of research institutions and minority-serving institutions (Historically Black Colleges and Universities; Hispanic-serving institutions; and tribal colleges). The purpose of the Alliance is to increase the numbers of students from groups that are underrepresented in research careers by providing research opportunities which might otherwise be unavailable, and career advice.

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