RUNNING HEAD: Female Scientists of Color

Female scientists of color:
How race, gender, and discipline intersect to shape their opportunities

I. INTRODUCTION

This research examines the intersection of race and gender in shaping opportunity to pursue careers in sciences, technology, engineering and mathematics (STEM) fields. The modest goals of gender and racial/ethnic parity have both been reached between the national undergraduate student population and the US population as a whole, but African Americans, Latinos, and American Indians remain underrepresented in graduate programs (See Fig.1 and Fig. 2). Although the data show women now overrepresented in degree-granting institutions overall, aggregated data such as these mask both persistent disparities within particular disciplines in the academy, as well as the unique nature of inequality borne of intersecting dimensions of identity.

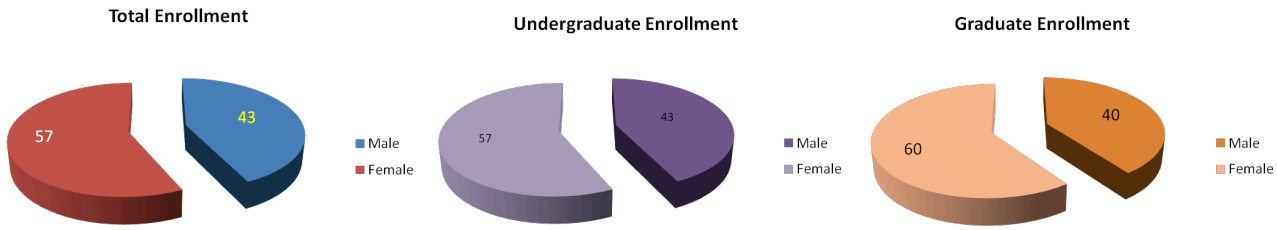

Fig.1: Total Fall 2005 enrollment in degree-granting institutions, by gender
Source: National Center for Educational Statistics

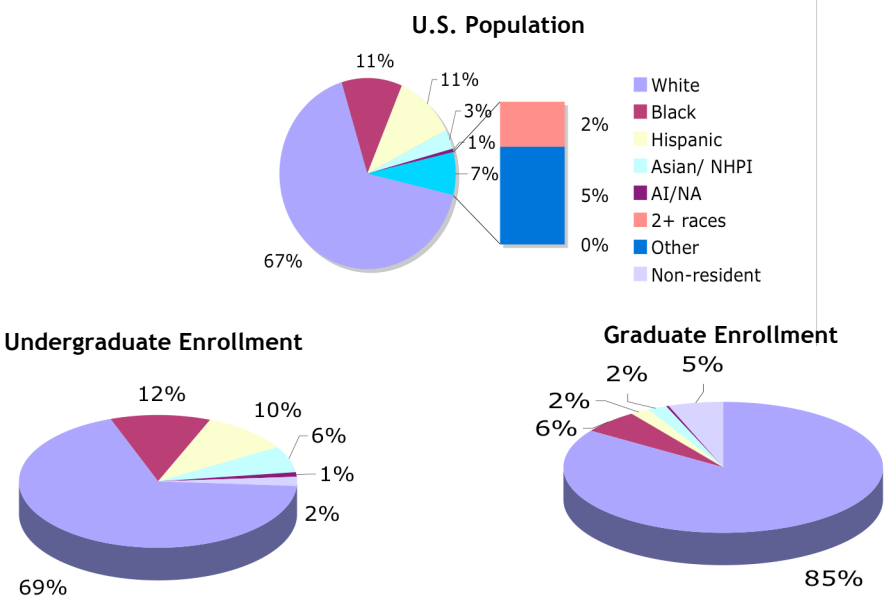

Fig. 2: 2000 U.S. Population and total Fall 2000 enrollment in degree-granting institutions, by race/ethnicity
Source: U.S. Census and National Center for Educational Statistics

When one looks at the intersection of race, gender, and academic field, the underrepresentation story looks very different. In STEM fields—and particularly within physics, chemistry, and engineering—women of color are so underrepresented that many statistical compilations leave their data out entirely to protect their anonymity. There are sub-disciplines in which women of color have never earned a doctorate. One's equal access to careers in STEM fields neither amounts to nor ensures equality in those fields, but equality requires equitable access; thus, improving access is both a precondition to and part of the realization of deeper equality. The purposes of this research, then, are (1) to examine the ways that race and gender intersect to shape access to careers in STEM disciplines and (2) to consider the roles that two programs at the University of Michigan have in increasing this access—the Undergraduate Research Opportunities Program (UROP) and Women in Science and Engineering (WISE).

II. CONCEPTUAL ISSUES

a. DEFINE RACE AND GENDER

Race is a socially constructed way of dividing the human population by phenotypes that has been politically reproduced since the colonial era. Race was created to justify social inequality and became a marker of inequality, specifically, the subordination of those who are not White to the domination of those who are White. Race, or "the color line" (DuBois, 1903), has been the basis for both individual prejudice and governmentally sponsored subjugation, including denial of personhood, rights, citizenship, and countless other manifestations of freedom.

Genders are the socially constructed meanings attached to the sexes, including the functional norms that dominate people's understanding of masculinity and femininity. In the last ten or so years, dialogue on gender has begun to open up to include not only traditionally female and male orientations toward self and the world, but also categories such as transgender (i.e.,

one's physical sex does not match gender identity/role), pangender (i.e., one cannot be labeled as female or male), and genderqueer (i.e., one takes a "both/and" approach to female and male) identities and roles. Like race, gender has been used as the basis for systematic domination of one portion of the population (in this case, males) over another (females).

From these definitions, it is clear that race and gender, like all socially constructed categories, are dynamic in meaning and laden with values. One's status—and I believe it is fair to say, one's freedom— is shaped by the salience of one's race, class, gender, national origin, sexuality, and religion in a particular temporal, geographic, and social context. More importantly that the ways that an individual's race, gender, and other dimensions of identity play out independently, however, are the ways that they intersect to shape experience on an individual level.

RACE / GENDER	Racialized ethnic groups/ People of color						
	African American	Latino/ Hispanic	Asian American	Native Hawaiian/ Pacific Islander	Amer Indian/ Alaskan Native	Multiracial	White/ Euro American
Male							
Female	x						
Other gender identities							

b. SIGNIFICANCE OF ONE CELL IN THE DIVERSITY DEBATES

The significance of the cell in which the female gender row and the African American race column intersect is in what it means for one's opportunities and experience not only to be Black and to be a woman (as separate dimensions of identity), but also to experience what statisticians would call the "interaction effects" that accrue from being a Black female. The effect

of identifying with both a subordinated race and a subordinated gender is greater than the sum of the individual effects that identifying as Black or female has for one's experiences and opportunities. A theoretically robust description of the meaning of intersectionality for Black women is advanced by Patricia Hill Collins, who introduced the concept of intersectionality to modern social science thinking as a paradigm that can account for social reality's complexity (Collins, 1998). If one's race is white or gender is male, intersectionality functions to counterbalance the oppression experienced as a result of the other dimension of identity being subordinated (e.g., being female, but also being white). However, for African American women, intersectionality functions as a double or "interlocking oppression" (Collins, 1998).

In the context of higher education and the pursuit of scientific careers, to be a Black woman means that one is in a small minority whether or not gender or race is most salient. While African American men and women are both critically underrepresented in the sciences, (Pascarella, Wolniak, Pierson, & Flowers, 2004) found that gender was significantly more important in predicting graduate school aspirations for African American women than it was for Hispanic and White students at the end of their third year of college. Controlling for all other influences in their regression equation, African American women had just one tenth of the odds of planning to earn a graduate degree as their male peers. Add to this structural disadvantage the history of Black women being viewed as objects, not agents, of knowledge (Collins, 1998, p. 97), and it becomes clear that it is not simply a matter of being in a minority among one's peers or colleagues in STEM fields, but of defying normative roles and resisting the force of history.

It is possible within the academy to think of one's discipline as a third dimension of identity with which race and gender intersect. Disciplines not only advance understanding of different types of knowledge, but they do so according to particular epistemologies and

ontologies. In sociology, Patricia Hill Collins could advance a theory grounded in her experience as a Black woman due to the discipline's relatively expansive epistemology and recognition of multiple realities. Rhonda Dzakpasu, a Black female physicist at UM whom I know, is very unlikely to have opportunity to integrate her standpoint into the content of her scholarship because of the narrowness of physics' epistemology and emphasis on a single, measurable reality. Much like race and gender, then, disciplines present unique ways of being in, understanding, and valuing the world; thus, for scholars they have power to shape one's experience and view of the world.

c. HOW WOULD SOCIAL CONTRACT THEORY VIEW THE INTERSECTION?

Taking individuals out of the state of nature and making them citizens of a civil society is the expressed purpose of the social contract, which was codified as a state sponsored arrangement through the Constitution. In this arrangement, citizens are inherently equal and inherently free, and the power of the government derives from their will. The individuals whom the Constitution tacitly empowers as free and equal citizens, however, are its authors and signatories: White, property-owning, males. While the gender and race-neutral language of "individuals" embedded in the Constitution gives the appearance of a gender and race-neutral social contract, "unwritten presuppositions about the proper role of women and the relations among the races limit the apparent universality of constitutional language" (Starr, 1992). This contradiction has had the effect of permitting de jure and de facto domination of women and people of color, such that "Modern contractual [domination] both denies *and presupposes women's [and non-Whites'] freedom* and could not operate without this presupposition" (Pateman, 1988).

Pateman and Mills argue that the creation of the social contract via the Constitution implicitly generated sexual and racial contracts that both formally excluded women and people of

color from the social contract and established structures of domination. Mills quotes a 19th century French imperial theorist, who eloquently expresses this idea with regard to race: "The subject people are not and cannot become citizen in the democratic sense of the term…It is necessary, then, to accept as a point of departure the fact that there is a hierarchy of races and civilizations, and that we belong to the superior race and civilization" (quoted in Mills, 1997, p. 25). Add to the collectively imagined hierarchies of race and civilization a hierarchy of sex, and you have the grounds for white supremacy and patriarchy.

Under the sexual and racial contracts, systems of slavery are intrinsically justifiable and serve as logical (i.e., effective and efficient) mechanisms for maintaining patriarchal white supremacy. At this level, the significance of race and gender's intersection viz a viz the social contract becomes clear, for "The body itself…is the foundation for all other levels" (Mills, 1997) of domination. "Exactly what form subordination takes, to what use the body is put or what kind of access is granted, depends on whether a man or woman is constituted as a subordinate" (Pateman, 1988, p. 231). Clearly, black women have been "constituted as subordinates" and the nature of their bodily subjugation has historically been more dehumanizing than that suffered by white women or Black males. For example, female slaves endured physical, sexual, and psychological violation that no wife of a slaveholder would ever be forced to experience. Between the sexual contract's fundamental appropriation of the female body as property and the slave system's formal, lawful possession of Black person's body as property, the Black woman's body was doubly not her own. Even today, not only are Black women subjugated as women and subjugated as Black, but the two are mutually reinforcing. Denigrating a person on the basis of race permits an even deeper disrespect of her body as a woman.

III. RESEARCH RELATED ISSUES

a. DATABASE SEARCH

i. See Appendix A for a sample of citations and abstracts obtained through the database searches conducted. Many additional searches were conducted and citations obtained; however, they are not included here so as not to bombard the readers with irrelevant or otherwise needless information about my database searching.

ii. Searches were conducted in the following databases:

1. ERIC-CSA and ERIC-First Search
2. Educational Abstracts
3. Web of Science
4. PsycInfo
5. Academic Search Premier.

b. b. LITERATURE REVIEW AND ARTICLE CRITIQUE

Among scholars who have analyzed the underrepresentation of women and people of color (and, in a few instances, women of color) in science, technology, engineering, and math (STEM) disciplines, a clear distinction can be made between literature on the pipeline to careers in the sciences and critically-oriented literature that acknowledges the ways that women of color are systematically excluded and marginalized in the sciences. Research based on pipeline assumptions views the problem as one of inequitable access to resources and an inadequate supply of scholars from historically oppressed groups, whereas the small, critically-oriented literature views the problem as inherent in the pipeline itself and in the use of the pipeline metaphor. These latter scholars contend that the process of becoming a scientist was developed by and for white males, and that the power structure established in the sciences since the mid 19th century (i.e., in research universities) systematically excludes women and people of color and marginalizes even those who make it through the pipeline. This literature review will critically discuss extant literature on women of color in STEM fields, including an extended analysis of the

role that undergraduate research programs play in providing aspiring scholars of color with early socialization to careers in the sciences.

Scholars have very rarely attended specifically to the underrepresentation and experiences of women of color in STEM fields (an assessment of the literature with which Clewell, 1991 and Orn, 2005 concur). Scholarship on female scholars of color in education and the social sciences is abundant in comparison, and from that body of work the entire theory of critical race feminism has emerged as an intellectual response to the experiences of double marginalization that women of color in the academy have endured. Indeed, it is from this work that intersectionality literature originated. In my review of the literature, however, only Ong (2005) employs intersectionality and critical race feminism in exploring underrepresentation of women of color in STEM fields. Just as a body of scholarship exists about women of color in the academy, in general, and in education and social sciences, more specifically, there is a large literature examining the underrepresentation of women in STEM fields; however, the vast majority of this does not explicitly consider the added impact of race, or it does so only tangentially (such as in concert with other individual-level characteristics). Less research has been conducted on the underrepresentation of people of color in science than women of science and here, too, only a small fraction of it analyzes the ways that gender compounds race-based inequities. The paucity of literature on women of color in STEM fields is easily apprehended through a Venn diagram, where each of the circles represents a subject of study and the size of the overlapping areas and of circles themselves represent the relative size of the literature on those subjects:

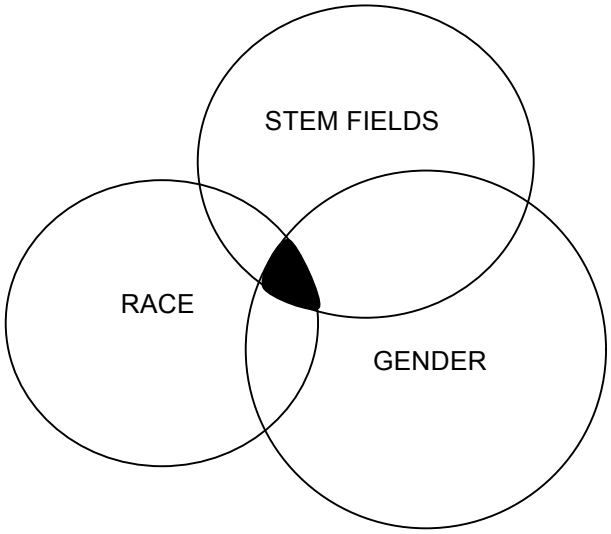

Fig. 1: The relative size of existing literature on the intersection of race and gender in STEM fields

Scholarship on the STEM pipeline

Pipeline scholars have identified barriers to participation in the sciences for women and people of color as separate challenges; however, intersectional analyses are absent from this literature. (Oakes, 1990) gives a prototypical assessment of this perspective. "Careers in science and technology result from students passing through a long educational 'pipeline.' Doing so successfully involves three critical factors: *opportunities* to learn science and mathematics, *achievement* in these subjects, and students' *decisions to pursue* them" (Oakes, 1990, p. vi). Women tend to leave during senior high school and college, she finds, and they do so because they *choose* not to pursue scientific careers. Students of color start out with greater interest in science during elementary school, but because of lower achievement, tend to be funneled into remedial tracks presenting limited opportunity for science related experiences (vii). That is, of the three factors that facilitate progress through the pipeline (i.e., opportunity, achievement, and decisions), she finds that women choose not to pursue science careers while people of color are

impeded by a combination of achievement and opportunity. Oakes advises, therefore, that educators should intervene at the places we know these groups tend to leak from the STEM career pipeline. She suggests altering the way science and math are taught at the elementary level will spur girls to consider science, and providing additional science exposure and role models in and out of the classroom to retain students of color (viii).

(Clewell & Anderson, 1991) reviewed the literature published between 1959 and 1990 on young women of color in the sciences and mathematics between grades four and eight, and found four general barriers impeded potential female scientists of color: student attitudes, student achievement, student selection of courses, and students' career interests and aspirations. Her review showed the tendency of the literature to explain underrepresentation in terms of student deficits. In this same vein, but on the other end of the pipeline, (Baker, 1998) analyzes persistence in science and engineering Ph.D. programs among women and students of color, finding that when he controlled for "ability" (questionably operationalized in terms of GRE scores and grade point averages), that sex and race differences in degree completion are significantly reduced. He does not indicate the effect for women of color, specifically, but does indicate that a gender gap persists even after controlling for GRE scores and GPA. His analysis conflates ability with test and academic performance, however, and uses measures shown to systematically vary by race and gender due to stereotype threat.

An alternative perspective shows that structural and cultural sources best explain attrition in STEM fields, not individual student adequacy or effort. This view sheds light on the external pressures on women and people of color that ultimately deter and exclude them from careers in the STEM disciplines. For example, (E. Seymour, 1992, 1995) actively debunks what she calls "attrition myth theories" such as Oakes', which explain students' leaving of STEM majors for the

social sciences and humanities to students' lack of ability, effort, or application. The "widespread acceptance of this theory functions to allow schools and departments to focus on weeding out those least fit to survive, and to regard their leaving as a sort of 'natural selection' process" (Seymour, 1992, p. 237). Exploring reasons for switching from science to non-science majors, she finds that "switchers" are just as academically successful, hard-working, and capable of facing the difficult conceptual content of STEM courses, but they less frequently use "situational resources" to overcome the challenges also faced by non-switchers (Seymour, 1992, p. 232). In addition, the structural barriers she cites include the need to work long hours to pay tuition, high school preparation, length of the major, teaching quality, and approachability. Non-switching seniors cited coping strategies as a reason for their persistence in the major. Seymour's perspective is a clear improvement on the deficit-based "attrition myth theories," but it does not explore the impact of race as strongly as it does class and gender-based structural explanations; furthermore, it takes for granted that the pipeline metaphor best describes the reasons for women's underrepresentation, even as it posits alternative explanations for the pipeline's leaks.

Alternatives to the pipeline metaphor

A multidimensional critique of pipeline explanations for women's underrepresentation in sciences and engineering is advanced by (Xie & Shauman, 2003) in his widely acclaimed book, *Women in Science*. The pipeline framework, Xie contends, inherently limits the scope of how we study gender disparities by conceiving of becoming a scientist as an overly linear, stage-based process that "equates noncompliance with the normative career trajectory to 'leaking' or 'dropping out'" (p. 9). Its narrow conceptualization also prevents alternate career trajectories from being seen as legitimate and overlooks the role of one's family, assuming that one's educational and occupational attainment are independent of other major life events. In addition to

problems with the ways that the pipeline metaphor unduly restricts conventional wisdom about career processes, most pipeline-oriented research suffers from methodological problems. His comprehensive analyses of the dynamic and multidimensional processes by which women enter the science and engineering labor force are guided by a life course theoretical framework, which is informed by a combination of structural allocation and self-selection theories. While Xie's (2003) research only tangentially studies the impact of race, it makes a critical contribution to the literature on access to STEM careers, the vast majority of which leaves the assumptions of pipeline logic unquestioned.

Orn (2005) also introduces fresh perspective to the research literature through a critical race feminist perspective. Moreover, she is the only scholar I could identify who acknowledges that intersectionality of race and gender in access to science. She finds intersecting identity has largely been ignored in the literature, and thus takes a consciously intersectional perspective in relating the findings of her longitudinal, qualitative study of female students of color in physics. Women of color in physics "sense that their belonging and competence in science are questioned because their bodies do not conform to prevalent images of the "ordinary" white male physicist" (p. 593). To persevere, her participants described two coping strategies: (1) gendered and racial passing, and (2) manipulating others' stereotypes of minority black women in the sciences by seeking to perform with superiority to their white and male peers. Lacking females of color with whom to identify in their own fields, these true pioneers in their discipline persist by avoiding and transcending stereotypes.

Undergraduate Research as a Means to Increase Access

To address persisting disparities for women and students of color in the sciences—particularly at the graduate school level and in the labor force—a variety of interventions have

been developed to retain students in the sciences at all levels. One prominent approach is involvement of college students in faculty-mentored, original research. Among other outcomes, undergraduate researchers have higher baccalaureate attainment rates (Nagda, et al, 1998), greater interest in science careers (Campbell & Skoog, 2004; Kremer & Bringle, 1990); Russell, 2007), and higher graduate school enrollment rates (Bauer & Bennett, 2003; Hearn, 1987; Russell, Hancock, & McCullough, 2007). The Boyer Commission (1998) thus urged research universities to create opportunities for all students to engage in research as one of ten recommendations for improving undergraduate education. Comparison group analyses, however, show that undergraduate research has a significantly stronger effect on the retention, aspirations and post-baccalaureate choices of students of color and first generation students' than those of white students and students whose parents attained a four-year degree (Hathaway, et al., 2002; Ishiyama, 2002; Nagda, et al., 1998; Russell, 2007).

Interestingly, in their program design, activities, and objectives many undergraduate research programs tend to reflect characteristics of both pipeline logic and the need to fundamentally rethink and restructure the process by which women and people of color approach the sciences. Consistent with pipeline-minded scholarship that emphasizes shoring up individual students otherwise at risk for attrition from the sciences, programs provide support structures to encourage academic success and increase students' self-confidence, for example. However, they do so through early socialization as a research scientist and extended engagement with faculty sponsors who can open doors that might have otherwise been closed – a particularly powerful experience for students from populations that have historically been marginalized in the sciences. Some programs, such as the Meyerhoff Scholars Program and McNair Scholars Program, explicitly emphasize connecting undergraduates with scholarly communities of color and role

modeling, with the goal of increasing faculty diversity across the country. Such programs affirm the pipeline principles of access and retention; however, they seek not only to plug the pipeline's leaks, but also to alter the entire process by which scholars pass through it and to prepare students for what to expect on the other end as a scholar of color in the academy.

Although numerous programs exist specifically for students underrepresented in their disciplines based on their race/ ethnicity, gender, and/or socioeconomic status, scholarship on undergraduate research has not approached students' experiences with an eye to intersecting identities. A mixed methods of how female graduate students in the sciences perceived the long-term impact of their undergraduate research experience (Campbell & Skoog, 2004) emphasized the mentoring role that the research experience provided—both from their faculty mentor and graduate students working in their lab. Through their early experience with research, these women also gained self-confidence as a scientist, a solid understanding of the time demands a lab-based science career would require, and had their career aspirations influenced in the direction of scientific research. Of course, such a retrospective methodology among those who have persisted suffers from the drawbacks of selection bias; we should expect relatively positive outcomes of research to be reported when the sample does not include undergraduate research participants who did not persist in pursuing scientific careers after college.

Among the many types of undergraduate research that are proliferating, the Undergraduate Research Opportunities Program (UROP) here at the University of Michigan has a strong national reputation and scholarship on UROP is some of the undergraduate research literature's most methodologically rigorous. UROP was specifically developed to improve retention of students of color by "broker[ing] intellectual relationships between faculty and first-year and sophomore undergraduates through research partnerships" (Nagda, et al., 1998, p. 58). Since most

undergraduate research programs serve upperclassmen, UROP's program design is unique, and a rigorous quantitative study confirms the program's success in meeting its primary objective: the attrition rate for African American participants in the 1993-1994 year was approximately half that of African American non-participants in a control group (Nagda, et al., 1997, p. 62). African American program participants demonstrate significantly higher retention outcomes than participants from other racial/ ethnic backgrounds. Although it has since opened participation to students of all racial/ethnic backgrounds, the program leadership retains a particular emphasis on the success of women and students of color in the sciences and has an emerging focus on facilitating graduate education and postgraduate research.

[1]In another study of UROP outcomes, (Hathaway, Nagda, & Gregerman, 2002) undertake an inquiry into whether undergraduate research participants and non research participants at the University of Michigan differ in their pursuit of graduate education, use of faculty recommendations for post-baccalaureate opportunities, and continued contact with faculty after graduation. In order to overcome the selection bias problem, researchers matched university alumni who had participated in the Undergraduate Research Opportunities Program (UROP) with non-participants based on major, race/ ethnicity, GPA, and graduation date (N=291). They were surprised to discover that, among non-participants, enough respondents indicated participation in non-UROP undergraduate research that they were able to construct a third comparison group (which they called other research students).

Through Chi squared analyses, they found that UROP and other research student alumni were significantly more likely to have pursued graduate education, to be involved in ongoing research, and to use faculty for recommendations. Overall, UROP and other research students

[1] Note: Article critique begins here.

were significantly more likely to pursue graduate education than students of color (African American and Latino) who had not participated in undergraduate research. UROP students were also most likely to pursue doctoral degrees—including law and medicine. While White and Asian student were most likely to pursue doctoral education across the entire sample, UROP students of color were as likely to pursue doctoral education as White and Asian UROP students.

By offering a sub-environment in which students engage the research university's mission and scientists critical in carrying out that mission, undergraduate research can counteract two institutional factors that deter students from the sciences: lack of faculty contact and a lack of community with other students. Clearly, UROP participation has particular benefit to students of color over and above the benefit of research participation, in general, a finding that motivates the need for deeper understanding. While the article offers a more methodologically sophisticated analysis of research outcomes for students, like most scholarship in this literature it is retrospective. Thus, it cannot provide evidence to show whether or how specific structures of research influence students, nor does it explain how the research experience may stimulate students' consideration of specific graduate degrees and/or careers.

In general, literature on the impact of undergraduate research participation suffers from two methodological problems: selection bias and retrospective analysis. Selection bias is endemic in the literature, as most studies sample only from within a given research program, neglecting to compare learning outcomes with a matched comparison group of non-participants. This practice makes it difficult to ascertain which outcomes are indeed a function of research participation and which are correlates of the predispositions that lead students to participate in research in the first place. Another weakness is a reliance on retrospective analysis. By asking past research participants to reflect back on their experience we learn valuable information about its long term

impact. Although such analysis does not necessarily weaken the validity of findings, it does prevent us from understanding how participants make meaning of the research experience while they are in it and *how* it is that research effects the beneficial outcomes that retrospective analyses have identified. In their methodological design, Hathaway, et al. (2002) overcomes the selection bias problem and is thus able to offer sound empirical support for the claims to research impact that many have posited without sufficient evidence. Applying this type of analysis to a set of longitudinal data would present an even stronger advance in the scholarship on the impact of undergraduate research.[2]

Like the two studies examining the impact of UROP participation on retention and graduate enrollment, (Barlow & Villarejo, 2004) likewise found that undergraduate research increased the likelihood that students of color majoring in a biological science would persist to graduation at University of California-Davis. Moreover, their participants were more likely to continue on to graduate education than graduates from the institution overall. The impact of undergraduate research experience on graduate school enrollment is well established for students in general, but particularly for students of color (Hathaway et al., 2002; Ishiyama, 2002; Russell et al., 2007; Elaine Seymour, Hunter, Laursen, & DeAntoni, 2004). However, in a large survey of 4500 undergraduate research participants and 3400 STEM degree recipients who had conducted undergraduate research, no significant differences were found by gender or race in program outcomes. "No formulaic combination of activities optimizes the undergraduate research opportunity, nor should providers structure their programs differently for unique racial/ ethnic minorities or women" (Russell, et al., 2007, p. 549). Rather, the duration of their research experience was most strongly correlated with reporting expectations of earning a Ph.D. Among

[2] Note: Article critique concludes here.

STEM field researchers, 73% said that the research experience raised their awareness of graduate school and 68% reported an increased interest in a STEM career as a result of their undergraduate research opportunity (Russell, et al., 2007).

Although women of color have made great strides in their educational and occupational attainment in the last forty years, access to careers in STEM fields represents a major frontier for race and gender equity in education. While the pipeline metaphor dominates the literature, the most current research advances alternative explanations for disparities that may empower scholars and practitioners to innovative scholarship and programming that extends opportunity to women scientists, especially those of color. Among these innovations are undergraduate research programs that use concrete research experience to stimulate the educational and career aspirations of students. Of particular relevance to the current analysis are findings from multiple studies showing that students from historically marginalized backgrounds disproportionately benefit from these programs, and that participation almost entirely erases baccalaureate attainment and graduate school enrollment gaps for women of color who major in STEM fields. However, resolving undergraduate retention and graduate school enrollment disparities does not resolve the persistent disparities in graduate degree attainment rates and attainment of both tenure-track faculty positions and tenure, itself.

IV. EXPERT INFORMANT INTERVIEWS

Based on my interests in the role undergraduate research plays in enhancing the opportunities of students of color and in access to STEM careers more specifically, I elected to conduct two interviews: one with Sandy Gregerman, director of Undergraduate Research Opportunities Program (UROP), and one with Cinda-Sue Davis, director of Women in Science and Engineering (WISE). WISE and UROP were founded explicitly to improve the retention and

achievement of women and students of color, respectively, but over the years have opened participation to students regardless of their demographic background. UROP expanded its participation to White students in the late 1990's as undergraduate research became nationally recognized as a beneficial mode and context for learning, and WISE opened to men just last year as a result of Proposal 2. In both cases, though, the program directors continue to derive their passion for the programs from the impact they have in increasing access and achievement. Moreover, both programs are funded through a combination of state general funds and federal grant funds, permitting the continuance of some programming specifically for women and students of color. Both admitted at the outset of our interviews, however, that they have much less expertise regarding the intersection of race and gender as it pertains to STEM career access than with women and students of color, as separate populations. Although women of color come through both programs, little programmatic attention is paid to the meaning of this intersection for their unique experiences.

WISE was founded in the late 1970s when Davis was pursuing her Ph.D. at UM in Biochemistry. Informally run for years by women faculty, they petitioned the central administration in 1980 to have a formal program established. The university's provost at the time, Billy Frye, had two daughters, and Davis believes this was critical to his willingness to have the program established. Early activities emphasized a group of female faculty Davis called "survivors of the system" teaching the next generation of female students and young faculty the rules of the science game, assuming that if they knew these rules that they would succeed. After several years of working in the research faculty as she started a family, Davis took the position of WISE director in 1984 and led the program in efforts to augment their pipeline efforts with deeper structural transformations within the university. This work included engagement with curricular

and pedagogical committees and bringing to light the inhospitable climate women faced in many STEM departments on campus.

UROP was created as an outgrowth of the Michigan Mandate. As the number of students of color increased and clear retention disparities were observed between white and non-white students, Psychology professor John Jonides looked to the research literature for academically oriented, non-remedial programming that might support students of color. Drawing on Tinto's theory of academic and social integration viz a viz student retention, they developed UROP. Although it was developed with an eye to retention and research showed its success in accomplishing this (Nagda, 1998), it became clear than an unintended outcome of the program was enhancing its participants' interest in graduate education (Hathaway, et al., 2002) and, because so many UROP projects have a biomedical focus, particularly in medical school.

Davis and Gregerman, who are both white, independently confirmed my assessment that the research literature is weak on the intersection of race and gender. I shared with both of them my assessment that the two primary perspectives in the literature about the access women of color have to STEM careers seem to be grounded in either pipeline or critical race feminist assumptions, and asked them which of these views seems to resonate with their professional experience. Davis grinned and answered, "It depends on the day."

Congruent with the pipeline and critical perspectives, but underacknowledged in the literature, they both emphasized the importance of having a sense of community within the discipline for women of color and, if not structural diversity is not present, a clear sense of inclusiveness in the closest groups with whom students work (e.g., one's research lab). Confirming this, Gregerman spoke about the specific majors to which women of color tend to gravitate, such as biopsychology for the structural diversity and to engineering for the strong

community of color. Davis affirmed the strength of the community in engineering, which she says is most clearly manifested through active student organizations such as Movement of Underrepresented Sisters in Engineering and Science (MUSES), Society of Women Engineers, and the National Society of Black Engineers as well as the University's MEPO and WISE programs. MUSES takes a particular interest in reaching out to female middle school students of color through mentoring, tutoring, and campus tours. Activities like these meet the desires women of color have to reach back and for community engagement, even as they pursue highly technical, frequently impersonal, academic fields. Although they indirectly make critical social contributions, engineering and sciences disciplines do not market themselves like social work, education, and psychology as disciplines whose work benefits society, and Davis believes this public image problem deters women of color. Having opportunities through groups such as MUSES then, presents an opportunity to for women to stay involved in social change issues interpersonally, and not just through developing technologies that will improve people's lives. At the same time, MUSES offers a mutually supportive network that enhances their own academic success.

In the post-Proposal 2 environment, groups like MUSES are more important than ever, since the policy has removed important resources that were used in the past to encourage student success. Of course, given the language of Proposal 2 emphasizing race and gender, women of color are once again uniquely caught in the crossfire. Particularly devastating for their efforts to retain current students, Gregerman and Davis say, is the withdrawal of designated scholarships for women of color. However, Davis spoke at length about the new challenges of recruiting students of color having positive effects for her program. With the new university-wide focus on outreach and community engagement, which is work that WISE has been involved in since 1990,

"Suddenly, we've become legitimized." Along with other university programs that have received minimal recognition for their decades of outreach to students in the K-12 system, WISE leadership is now at the forefront of the university's outreach strategies. Davis has been a primary consultant in the development of Tony England's Office of Engineering Outreach and Engagement (OE^2), and both she and Gregerman are key players in the development of the M-STEM Academy, which will offer a first year living-learning community to students admitted to UM through OE^2.

The University of Michigan goes back and forth with Georgia Tech as the institution enrolling the most women in STEM fields, and only HBCU's graduate more African American engineers than UM. Maintaining its national leadership in promoting STEM career access in the post-Proposal 2 environment has created a sense of urgency that Davis believes has and will stimulate new creativity and strategies. It has also generated the political will in the administration to use every mechanism at the university's disposal to foster access. "We're far from where we need to be," Davis concluded, but she and Gregerman remain optimistic about the university's capacity to maintain a real commitment to the success of women of color. Indeed, they remain in this work because they believe well structured learning environments can make a difference that transcends the forces of policy and history.

V. CONCLUSIONS, or "Access to what?"

I am struck in considering Davis and Gregerman's comments by their implicit assumption that institutional commitment to access is the primary force by which said access is achieved. Institutional commitment does not ensure commitment at the level of individual departments/ majors or by individual faculty for their students' success. The institution plays a critical role in recruitment and retention, but individual students' primary contexts for learning and career

advancement are within smaller organizations, such as research groups, departments, and disciplines. Thus, in addition to crafting and supporting co-curricular programs that bridge academic and student affairs such as UROP and WISE, the university has an obligation to vigorously cultivate inclusive cultures within departments. After all, what we want women of color to have access to in their careers as scientists and engineers is not simply the job of scientist or engineer. Fundamental among the institutional resources we must push for is access to the freedom to participate in these fields as respected equals. Although I do not know how this is to be achieved, in part because of my own standpoint as a white woman outside the STEM disciplines, there are two qualities to the sort of academic freedom I envision:

Community. While collegiality is touted as a defining norm of higher education, women scientists of color are frequently denied opportunity to share in it fully. The shamefulness of their systematic exclusion through history is only slightly worse than the systematic marginalization prevalent in the academy today, and is a major hindrance to the realization of academic community. Prerequisite to such community, however, is a genuine effort among current white, male scholars to increase the numbers of women of color, who presently "sense that their belonging and competence in science are questioned because their bodies do not conform to prevalent images of the 'ordinary' white male physicist" (Ong, 2005, p. 593). There also remains an important place for access-oriented undergraduate research programs seeking to increase faculty diversity as well as programs to keep young women of color engaged in the pipeline from young age. As we seek solutions to systematic racism, the realization of community will also require facing the ways that the racial and sexual contracts play out in individual relationships and in the exclusionary structure of academic prestige. Female scientists of color will remain

relegated to structures of domination that preclude the realization of true collegiality as long as the racial and sexual contracts hold sway,.

Opportunity to (re)define knowledge. The racial and sexual contracts also require women of color to participate in STEM fields on terms they have not participated in defining. Therefore, the second characteristic of the sort of academic freedom I argue we should be seeking access to is opportunity to (re)shape the disciplines. Such participation would more equitably distribute freedoms to lead paradigmatic shifts, to challenge the "content and process of scientific knowledge" (Collins, 1998, p. 120) as, for example, critical race feminists have in the social sciences. As I envision it, scholars at all levels might be able to participate in this—whether it is through a federally funded grant one receives as a faculty member, through a graduate student research assistantship, or through an undergraduate research fellowship. Although we have not discussed a gender corollary, I believe that epistemological racism represents a major barrier for all people of color in STEM fields. After all, the prevailing scientific paradigms and epistemologies have derived from white social history, and because they have been specifically defined as narrow and exclusionary, they are doubly resistant to change.

In higher education, we traditionally think of academic freedom as a cornerstone of both the academy's reason for being and its modus operandi. It is a powerful value that lures many scholars into academic careers. Thus, while we attend to the disparities by race and gender that continue to exist and work to eradicate them, an important part of that work must be to improve access to the most basic forms of academic freedom. I am convinced that it is no accomplishment for women and people of color to be technically included but marginalized as unequal participants. As a result of this course and this research, therefore, I intend to take my own study

of educational inequality to a deeper level by studying the ways that research universities' organization of knowledge inequitably structures opportunity.

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