Analysis of Workplace Climate for Female Faculty of Color in Computer Science and Engineering

Dr. Ona Egbue, University of South Carolina Upstate

Ona Egbue is an assistant professor in the Department of Informatics and Engineering Systems at the University of South Carolina Upstate. She holds a Ph.D. in Engineering Management, a master's degree in Earth and Environmental Resource Management and a Bachelor of Engineering degree in Electrical/Electronics Engineering. Her research interests include sustainable energy and transportation systems, socio-technical system analysis, innovation management and engineering education.

Dr. Arshia Khan, University of Minnesota Duluth

Arshia A. Khan, Associate Professor at the University of Minnesota Duluth, earned a Bachelor of Engineering in Computer-Engineering, M.S. in Computer Science and Ph.D in Information Technology. Her research interests are interdisciplinary and span the biomedical informatics, clinical/health informatics, and consumer health informatics. Her research is on sensor based wireless, robotic non-intrusive device development for monitoring physiological changes for population health management, mobile clinical decision support, and data analysis. She authored "Objective-C and iOS Programming: A simplistic Approach"

Dr. Rania Al-Hammoud P.Eng., University of Waterloo

Dr. Al-Hammoud is a Faculty lecturer (Graduate Attributes) in the department of civil and environmental engineering at the University of Waterloo. Dr. Al-Hammoud has a passion for teaching where she continuously seeks new technologies to involve students in their learning process. She is actively involved in the Ideas Clinic, a major experiential learning initiative at the University of Waterloo. She is also responsible for developing a process and assessing graduate attributes at the department to target areas for improvement in the curriculum. This resulted in several publications in this educational research areas. Dr. Al-Hammoud won the "Ameet and Meena Chakma award for exceptional teaching by a student" in 2014 and the "Engineering Society Teaching Award" in 2016 and the "Outstanding Performance Award" in 2018 from University of Waterloo. Her students regard her as an innovative teacher who continuously introduces new ideas to the classroom that increases their engagement.

Analysis of Workplace Climate for Female Faculty of Color in Computer Science and Engineering

Abstract

The underrepresentation of female faculty in science, technology, engineering and mathematics departments is well documented. In computer science and engineering particularly, the dearth of female faculty is even more pronounced. Diversity of faculty in these disciplines is important because it has direct implications for the diversity and quality of future engineering and computer science workforce. Diversity and inclusion are very important parts of campus climate. Therefore, it is critical for universities to have a welcoming climate in order to retain female faculty and foster an environment where they can thrive. This preliminary study examines diversity issues related to female faculty of color with a focus on professional concerns that are unique to this group of female faculty in computer science and engineering. This paper examines current literature and data to identify key factors that affect workplace climate for this group of faculty. Furthermore, this paper identifies gaps in existing studies and will inform the development of a study on the experiences of female faculty of color in computer science and engineering related to workplace climate.

1. Introduction

In recent years, the focus on Science, Technology, Engineering and Mathematics (STEM) education has resulted in an increase in the number of studies about underrepresented faculty in STEM fields. These studies have focused on several areas including recruitment, retention and workplace climate. Women, one of the underrepresented groups, are even less represented in Engineering and Computing fields compared to other STEM fields. Far less research has focused on female faculty of color in engineering and computer science. In addition to the barriers related to gender, this group of faculty also face barriers related to their race or ethnicity. According to Leggon [1], studies on underrepresentation in science focus on two main areas including minorities and females and this focus can be partly attributed to the way data on science workforce have been traditionally gathered: by race/ethnicity or by gender. As a result of this separation between race and gender, some issues facing women of color remain invisible.

This preliminary paper will explore barriers facing female faculty of color in engineering and computing through a survey of existing literature. This study is a work in progress and the purpose is to trigger a discussion about obstacles faced by this group of underrepresented faculty and to gather suggestions for the development of a survey. This survey will provide the basis for a study to examine the issues specific to female faculty of color in engineering and computing in order to provide insights into these issues and inform decision-making on how to address them and provide a work environment that supports the success of this minority group.

2. Literature Review

Challenges that female faculty of color face in STEM fields, particularly in engineering and computer science disciplines, are numerous. However, for the purpose of this study we limit

our areas of focus to issues that stem from stereotypes, gender and racial biases, negative classroom experiences (particularly in student evaluations), research barriers, and lack of institutional support.

2.1. Stereotype

Gender and racial bias which affects how we perceive and treat one another is shaped by cultural stereotypes. Despite a decline in explicit or self-reported bias, implicit or unconscious bias remains widespread [2]. Babcock and Laschever [3] showed that even women themselves hold stereotypes about women and that women undervalue the work that they perform. A study found pervasive gender discrimination among science faculty where faculty were more likely to choose a male candidate over a female candidate for a student science-laboratory position [4]. In this case, both male and female scientists offered a higher salary to a male candidate than they did to an identical female candidate. Although this particular study was on faculty bias against student applicants, an argument can be made that gender bias extends to the hiring of faculty particularly because faculty search committees which usually are comprised of faculty in the same field or similar fields as the candidates typically have significant impact on faculty hiring decisions. These studies highlight the impacts of stereotypes and gender bias on female faculty in engineering and computing. Gender stereotypes, particularly stereotypes that females are underperformers in math and science and are therefore not good fits for these fields, may even be stronger in engineering and computer science.

Stereotype threat can occur as a result of the negative stereotypes that female faculty of color in engineering and computer science experience. Stereotype threat is the fear individuals have of confirming a negative stereotype about a group to which they belong [5]. Stereotype threat has been shown to negatively impact performance [6]. It has also been shown to reduce women's engagement in fields where they are negatively stereotyped such as engineering and computer science. A study by Holleran et al. [7] found that the more female STEM faculty had conversations about research with their male counterparts, they felt less engaged with their work. On the other hand, social conversations with their male counterparts was associated with less disengagement. Holleran et al. [7] argue that the disengagement associated with female faculty having research related conversations with male faculty is due to stereotype threat while social conversations reduce the stereotype threat. Overall negative stereotypes and the associated stereotype threats have negative impact on female faculty and even more so on female faculty of color.

2.2. Gender and Racial Bias

Bias against female faculty in academia is increased for females in STEM fields and even more so for women of color in STEM fields. A study by Easterly and Ricard [8] found institutions of higher education to be gendered institutions with males holding the majority of professorships and higher administration positions. While the number of females in STEM fields in higher education including engineering and computer science has increased, females have advanced at a slower rate compared to their male counterparts. One reason for this disparity is bias or discrimination. According to Meyerson and Fletcher [9], gender discrimination still exists but has gone underground. The authors argue that rather than overt discrimination, bias against females exists in practices and norms that do not appear to be biased. Unconscious bias against

females in academia is prevalent. For example, recommenders who wrote letters of recommendation for medical faculty for promotion and tenure or for new jobs displayed implicit bias against females by being more likely (two and half times more than for males) to write short letters with limited assurance for females compared to males [10]. The authors found that letters written for female applicants were more likely to include doubt raisers and were more likely to support gender schema that characterize females as teachers and students while representing males as professionals and researchers [10].

A study by Malcom, Brown, and Hall [11] described the double bind which is the notion that women of color in science face discrimination based on their race or ethnicity and gender. This double bind is evident in a study by Williams, Phillips and Hall [12] which found different types of gender bias in the STEM workplace with dramatic differences by race. Black female scientists were more likely to report having to provide more evidence of competence than their colleagues, female Asian-American scientists were more likely to receive pushback if they did not behave in feminine ways and female Latino scientists were more likely to be labeled as "angry" if they behaved assertively [12]. The study found that although it was common for the black scientists to attribute the problem of having to prove themselves more than their colleagues to race, some respondents expressed uncertainty about whether race or gender was the issue. In engineering and computer where female faculty of color are even less represented, this bias is likely to be heightened with more dramatic impacts.

2.3. Teaching Evaluations and Research

Teacher evaluation results are aimed at improving teaching quality and are typically used for the assessment of a faculty's teaching performance. However, there are biases in faculty evaluation that affect the authenticity of results and cause unfair treatment of teachers. The most common biases in faculty evaluations result from the following: teacher-related factors, student-related factors, and course-related factors [13]. Students and teachers' gender, age and race affect faculty evaluation but have no relation to teaching effectiveness [13], [14]. There is a tendency for same-gender preferences in faculty evaluation where male students favor male instructors over female instructors and vice versa [15]. Also, an experiment conducted in an online class setting where instructors used a false gender identity showed that students gave the instructors whom they thought were male a higher rating than instructors they thought were female. One explanation for this finding is that women in academia are often seen as less accomplished and less capable than their male counterparts regardless of their achievements and as a result, receive lower ratings [16]. Most evaluations do not reflect the faculty's knowledge, clarity and organization, but show students' attitudes towards the class and instructor instead of information on teaching performance, resulting in some instructors receiving higher rating by offering students extra grades [14], [17].

There are fewer studies conducted on minority faculty research, especially females and racial minorities, compared to studies on faculty evaluations [18]. Furthermore, females typically spend more time on teaching and advising, reducing the time that could be used for research purposes [18]. Many minority professors find it difficult to get tenure compared to their white or male counterparts and find that their research is undervalued for being considered less academic than standard [18]. In STEM fields specifically, it is found that women and minority faculty have a very different experience compared to male and European white faculty [19]

Researchers have contended that since STEM fields have high status in our society, they demonstrate the current societal beliefs and inequity [19].

2.4. Recruitment and Retention

Several criteria have been identified as essential for the success of women and faculty of color, such as a need for critical mass, quality of life, responsibilities, teaching support, pipeline from K-12 through graduate school, climate of the school [20]-[23]. A national analysis of diversity in science and engineering among the top 50 science and engineering schools on tenured and tenure-track faculty has revealed that Black, Hispanic and Native American women are almost non-existent in tenured and tenure-track positions at universities studied. Students look upon faculty to serve as role models. Therefore, the scarcity of female faculty of color greatly reduces the likelihood of minority faculty serving as role models for students from minority groups leading to a low sense of belonging. In some engineering and computer science programs, there may be no female faculty of color. In fact, the lack of faculty of color has resulted in fewer students of color [20]. An increase in the population of female faculty of color will help create an atmosphere that fosters community, support and a sense of belonging which are necessary for success.

3. Discussion and Recommendations

3.1. Stereotypes and Bias

Research shows that women are more likely to encounter stereotype threat in an organization where few women work such as in fields of engineering and computer science. In addition to gender stereotypes, female faculty of color in engineering and computer science encounter additional stereotypes. This is because they have to deal with stereotype threats associated with their gender as well as threats associated with their race. For instance, the perception that African Americans lack the skills to be successful in STEM fields combined with gender stereotypes makes it even more difficult for African American women to be successful in these fields. A study by Gutidrrez y Muhs et al. [24] shows that black women are presumed to be incompetent in both research and teaching.

A combination of stereotypes and biases experienced by female faculty of color can contribute to this group lacking a high sense of belonging in their workplace. While overt biases have reduced over time, unconscious biases remain strong. These biases can be just as impactful as the overt biases. There appears to be various biases that may be unique to certain races or ethnicities. Therefore, some biases that black women face will differ from biases Asian, and Latino women in engineering and computing face. As a result, education is critical to create awareness of these biases. More educational programs should be directed towards implicit biases since these are biases we all hold. Education makes people more aware of biases they hold and thus can result in better management of the biases.

3.2. Teaching Evaluations

Due to the issues with teaching evaluations identified in section 2.3, evaluations should only be used to draw general conclusions about teaching effectiveness. Methods to combat bias include

administering multiple formal and informal evaluations throughout the course of the semester, keeping a teaching portfolio and inviting other faculty to sit in on lectures and evaluate the instructors' teaching [25]. Suggestions for further study include conducting a cross-cultural study on faculty evaluation perceptions to determine if there's a relationship between national culture and the evaluation process as well as research to determine the impact of student and instructor race and gender, on instructor ratings [26]. Other suggestions include conducting periodic assessments to determine which biases come into play in faculty evaluations and administering evaluations without notifying students [27].

In general, it is recommended to use standardized assessment forms to gather information to maintain consistency and make fair comparisons and to consider the factors such as gender, race and background of class.

3.3. Recruitment and Retention

Recommended actions to improve the work environment and experience for minorities and their colleagues include creating more transparent organizational processes and structures, creating family friendly policies and programs, creating networking opportunities, clarifying policies regarding harassment, promotion/rewards, and mentoring [28]-[30]. Mentoring has been identified as an essential component to offer support, guidance and encouragement to achieve tenure and promotion. Mentors have a positive impact on women's self-esteem, job satisfaction and work-life balance [31]. Furthermore, mentoring can prove to be especially beneficial to mid-career faculty, who have attained the associate rank but lack the support, resources and encouragement required to get to the rank of full professor [20], [21], [22], [32], [33]. Collaborative mentoring can have a positive impact on productivity, and researchers have found that college women found that female mentors inspired them more than male mentors [31].

Another important factor in the retention and promotion of female faculty of color is role modeling. Disproportionate numbers of male versus female faculty role models creates an atmosphere that unconsciously encourages discrimination. Students sub-consciously observe the lack of female and faculty of color role models and assume that they are not existent in science and engineering fields, while the minority groups subconsciously believe that they are not worthy of science and engineering fields. This creates a dynamic and damaging cycle that need to be eliminated [21], [22], [34].

Improvement in campus climate is another essential element for the success of female and faculty of color. A climate that is full of microaggressions and lacks resources can be devastating for the growth of the faculty. Putting policies in place that can reduce the microaggressions can help curb negative climate and help foster an atmosphere of support [32]. Furthermore, climate has been identified as one of the critical elements in creating an atmosphere of support and encouragement with equity in resource availability. Having equal access to resources that can aid in the success of the faculty is of utmost importance. Understanding the differences in culture and ethnic awareness to create an atmosphere of support that can help foster growth is a critical element for the female and faculty from minority backgrounds to flourish.

Clarity in policies and follow through in the implementation of these policies has been identified as one of the elements to aid the success of retention and hiring of female and faculty of color. Hence for female faculty of color to succeed, it is essential to carve out a plan that strives to meet their needs.

Workshops, training sessions, personal development opportunities, teaching training, research maximizing training and opportunities to network and create collaborations can help assist in this endeavor. Besides work support, it is also important to ensure work-life balance, adjustments to teaching schedules, encourage new and creative teaching and research methods, help faculty develop promotion plans, and finally the repeated assertion of proper mentoring are needed for female and faculty of minority groups to succeed [34]. Furthermore, contextual counseling can offer substantial support on how to deal with special situations such as responding to special scenarios in a classroom or addressing publication concerns. Counseling can prove helpful to address training that cannot be undertaken in other circumstances [20].

4. Survey Development

This aim of this survey is to identify key factors that affect workplace climate for female faculty of color in the United States and Canada and to provide recommendations for improvement. Data collection for the study will be conducted using online surveys and semi-structured interviews. Based on the literature survey conducted in this paper, the focus areas for the survey will include issues related to stereotypes and biases, sense of belonging, and bias in student evaluations. Although this survey focuses on female faculty of color, the sample to be analyzed will include both female and male respondents to gather multiple perspectives on the issues. This broader sample allows for an analysis of how the experiences of female faculty of color are perceived by other faculty and how similarities or differences in experiences and perceptions may influence the workplace climate.

Based on the search of the literature, questions included in the survey will address perceptions about engineering and computer science fields as it relates to gender and race, stereotypes of female faculty of color and how these stereotypes in turn affect performance and overall experience in the workplace. In regard to teaching evaluations, survey questions will address perceptions of fairness of student teaching evaluations and awareness of bias in evaluation by both female faculty of color and other non-minority faculty. Questions will address availability of support programs to balance family responsibilities with career development, availability of support programs including formal and informal mentoring programs (including availability of female faculty of color mentors), and the perception of effectiveness of these programs. Other questions will address the research support available and the balance between teaching, research and service. Female faculty of color are more likely to have higher service loads compared to other female faculty and non-minority faculty. Yet there is typically no reduction in either research and teaching expectations compared to other faculty. Furthermore, the survey will ask about the availability of educational programs geared towards diversity and inclusion including the availability of training programs that address bias (implicit and overt biases).

The study will also analyze similarities and differences between experiences of faculty in institutions in Canada and the United States. Results of this study will provide a better

understanding of how perspectives on workplace climate for female faculty of color differ and how differences in attitudes and perception shape the climate. Furthermore, this study will provide recommendations on strategies that promote a workplace climate where female faculty of color in computer science and engineering can thrive.

5. Conclusion

Studies shows that gender and racial biases still exists. However, many of these biases may be implicit and not very obvious. Unconscious bias negatively affects women of color in computer science and engineering and can create an unwelcoming climate, reduce their sense of belonging and result in an environment where the advancement of female faculty of color is limited. This preliminary study identifies challenges, including, bias and stereotypes and unwelcoming workplace climates, facing female faculty of color in engineering and computer science. Some of these issues have been identified in broader STEM studies as few studies on female faculty of color experiences in engineering and computing fields exist. Therefore, this study serves as the first step in the development of comprehensive survey tool for a more in-depth analysis of the current state of the workplace climate for female faculty of color in engineering and computing. An in-depth understanding of the climate and associated issues will aid in the development of measures aimed at offering a better climate so that female faculty of color in engineering and computing can thrive in their careers.

References

[1] C. B. Leggon, "Women in Science: Racial and Ethnic Differences and the Differences They Make" *Journal of Technology Transfer*, 31, 325–333, 2006.

[2] C. Corbett, & C. Hill. "Solving the equation: The variables for women's success in engineering and computing". *Washington, DC: American Association of University Women*, 2015.

[3] L. Babcock, L., & S. Laschever, "Women don't ask: The high cost of avoiding negotiation and positive strategies for change". *New York, NY: Bantam Books, 2007*.

[4] C A. Moss-Racusin, J. F. Dovidio, V. L. Brescoll, M. J. Graham, & J. Handelsman, "Science faculty's subtle gender biases favor male students". *Proceedings of the National Academy of Sciences*, vol. 109, no. 41, pp. 16474–16479, 2012.

[5] S. Cheryan, S. A. Ziegler, A. K. Montoya, and L. Jiang. "Why are some STEM fields more gender balanced than others?" *Psychological Bulletin* vol. 143, no. 1, pp.1–35, 2017.

[6] J. C. Croizet, G. Despres, M. E Gauzins, P. Huguet, J. P. Leyens, & A. Meot, "Stereotype threat undermines intellectual performance by triggering a disruptive mental load". *Personality and Social Psychology Bulletin, vol. 30*, no. 6, pp. 721–31, 2004.

[7] S. E. Holleran, J. Whitehead, T. Schmader, & M. R. Mehl, "Talking shop and shooting the breeze: A study of workplace conversation and job disengagement among STEM faculty". *Social Psychological and Personality Science, vol. 2*, no. 1, pp. 65–71, 2011.

[8] D. M. Easterly, and C. S. Ricard. “Conscious efforts to end unconscious bias: Why women leave academic research”. *Journal of Research Administration* vol. 42, no. 1, pp.61–73, 2011.

[9] D. E. Meyerson, & J. K. Fletcher , “A modest manifesto for shattering the glass ceiling”. *Harvard Business Review*, pp. 127-136, 2000.

[10] F. Trix, & C Psenka, “Exploring the color of glass: Letters of recommendation for female and male medical faculty”. *Discourse and society, 14*, pp. 191-220, 2003.

[11] S. M. Malcom, J. W. Brown, and P. Q. Hall. “The Double Bind: The price of being a minority woman in science”. *American Association for the Advancement of Science Publication*, 76-R-3, 1976. Washington, DC.

[12] J. C. Williams, , K. W. Phillips, and E. V. Hall. “Tools for change: Boosting the retention of women in the STEM pipeline”. *Journal of Research in Gender Studies* vol. 6, no. 1, pp. 11–75, 2016.

[13] J. S. Pounder, “Is student evaluation of teaching worthwhile: An analytical framework for answering the question”, *Quality Assurance in Education*, vol. *15, no. 2*, pp. 178-191, 2007.

[14] D. J. Merritt, “Bias, the Brain, and Student Evaluations of Teaching”. *SSRN Electronic Journal, vol. 82*, no. 235,2008.

[15] J. A. Centra, & N. B. Gaubatz, “Is There Gender Bias in Student Evaluations of Teaching?”, *The Journal of Higher Education*, 71(1), 17-33, 2000.

[16] L. MacNell, & A. Driscoll, & A. N. Hunt, “What’s in a Name: Exposing Gender Bias in Student Ratings of Teaching”, *Innovative Higher Education, 40*(4), 291, 2015

[17] P. C. Abrami, “Improving Judgments About Teaching Effectiveness Using Teacher Rating Forms”. *New Directions for Institutional Research, 2001*(109), 59–87, 2001. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/ir.4/epdf

[18] T. Boyd, R. Cintrón, & M. Alexander-Snow. "The Experience of Being a Junior Minority Female Faculty Member." *Forum on public policy online*. 2010 (2). Oxford Round Table. Urbana, IL, 2010.

[19] L. V. Blackwell, , L. A. Snyder, & C. Mavriplis. “Diverse faculty in STEM fields: Attitudes, performance, and fair treatment.” *Journal of Diversity in Higher Education, 2*(4), 195, 2009

[20] C.C. Bartman, “African American women in higher education: Issues and support strategies.” *College Student Affairs Leadership*, vol. *2*, no.2, 2015.

[21] S. R. Lowenstein, G. Fernandez, & L. A. Crane. “Medical school faculty discontent: prevalence and predictors of intent to leave academic careers”. *BMC Medical Education*, vol. *7*, no. 1, 2007

[22] L. P. Huber, O. Huidor, , M. C. Malagón, G. Sánchez, & D. G. Solórzano, “Falling through the Cracks: Critical Transitions in the Latina/o Educational Pipeline.” 2006 Latina/o Education Summit Report. CSRC Research Report. No. 7. *UCLA Chicano Studies Research Center (NJ1)*, 2006

[23] W. A., Anderson, U. Banerjee, C. L. Drennan, S. C. R Elgin, I. R., Epstein, J. Handelsman, & S. A. Strobel, "Changing the culture of science education at research universities." *Science*, vol. *331, no.* 6014, pp. 152-153, 2011

[24] G. Gutifrrez y Muhs, Y. Flores Neimann, C. G. Gonzilez, & A. P. Harris, "Presumed Incompetent: The Intersections of Race and Class for Women in Academia*". Boulder, CO: Utah State University Press*, 2012.

[25] T. Baldwin, & N. Blattner, "Guarding Against Potential Bias in Student Evaluations: What Every Faculty Member Needs to Know", *College Teaching*, *51*(1), 27- 32, 2003. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/87567550309596407?needAccess=true

[26] M. Germaine, & T. A. Scandura, "Grade inflation and student individual differences as systematic bias in faculty evaluations". *Journal of Instructional Psychology, 32*(1), 58, 2005.

[27] S. Steiner, L. C. Holley, K. Gerdes, & H. E. Campbell, "Evaluating Teaching: Listening to Students while Acknowledging Bias", *Journal of Social Work Education, 42*(2), 355-376, 2006.

[28] L. Kloot, "Women and leadership in universities: A case study of women academic managers." *International Journal of Public Sector Management*, vol. *17*, pp. 470–485, 2004

[29] R. Marschke, S. Laursen, J. M. Nielsen, & P. Rankin "Demographic inertia revisited: An immodest proposal to achieve equitable gender representation among faculty in higher education." *Journal of Higher Education*, vol. *78*, pp. 1–26, 2007

[30] G. Sonnet, "Gender equity in science: Still an Ilusive goal." *Issues in Science and Technology*, vol.*12*, pp. 53–58, 1995

[31] L. M. Frehill, N. Di Fabio, P. Layne, A. T. Johnson, & S. Hood, "Women in engineering." *Society of Women Engineers, vol. 53 no. 3*, pp. 1-24, 2007. Retrieved from https://societyofwomenengineers.swe.org/images/stories/2006LitRev.pdf

[32] J. R. Ancis, W. E. Sedlacek, & J. J. Mohr. "Student perceptions of campus cultural climate by race." *Journal of Counseling & Development*, vol. *78*, no. 2, pp. 180-185, 2000

[33] D. J. Nelson & D. C. Rogers . "A national analysis of diversity in science and engineering faculties at research universities." Washington, DC: National Organization for Women. 2003.

[34] A. M. Canale, C. Herdklotz, & L. Wild, L. "Mid-career faculty support: The middle years of the academic profession." *Faculty Career Development Services, the Wallace Center, Rochester Institute of Technology*. 2013