

Engineering Students Define Diversity: An Uncommon Thread

Lorraine N. Fleming, PhD, Howard University, College of Engineering
Dawn G. Williams, PhD, Howard University, School of Education

CONTEXT

Burgeoning research on diversity in engineering consistently reveals that engineering struggles to keep pace with trends in the increasing global marketplace (Chubin, May, and Babco, 2005). Women and minorities who start their engineering education, experience higher attrition rates in matriculation and are far more likely to defect to other fields than their white male counterparts (French, Immekus, Oakes, William, 2005). Critical is the rate and level of preparedness to which women and minorities are exposed that prepares them to succeed in a rigorous engineering program. In 2002, women earned more than half of the degrees awarded in psychology (78%), biological/agricultural sciences (59%), social sciences (55%), and almost half (47%) in mathematics. However, women received only 21% of bachelors degrees awarded in engineering, 27% in computer sciences, and 43% in physical sciences (National Science Foundation). These gaps persist despite the higher average salary (40K+) that newly minted engineers command compared to other new Baccalaureates.

Diversity has come to mean a lot of different things depending on the context in which it is used and the person using it. As a corporate term, diversity evolved out of the civil rights movement of the 1960s and 1970s. In the 1980s, it served as a means of penetrating the dominant ethos of many institutions that aimed to preserve the white male culture. More recently, diversity has been used to include an array of conditions that represent people who feel disenfranchised and excluded. Administrators, educators and students continue to grapple with ways to increase sensitivity, enrollment, and ultimately a more diverse pool of engineers. Broadening the pool of engineers is not merely an exercise in futility, it is essential to the integrity, validity, and survival of the engineering field. Many studies have investigated reasons for the lack of representation of women and minorities in STEM degree programs (Haden, 2007; Maple and Stage, 1991; May and Chubin, 2003). Following a path of seeming ambiguity, today's engineering students have come to embody diversity as an extension of their home, academic and social environments (Foor, Walden and Trytten, 2007).

RESEARCH QUESTIONS

General research questions sought to inquire more about undergraduate engineering students' perspectives of diversity.

1. How does this generation of undergraduate engineering students define diversity?
2. How do students classify diversity within their academic settings?
3. How do students perceive that their race and gender impacts their goal of becoming an engineer?

This array of questions did not allow for the researchers to pre-impose a definition of diversity, but rather learn the students' definitions of diversity and later its internal or individual impact.

THEORETICAL FRAMEWORKS

Initially utilizing a grounded theory approach, two theoretical explanations surfaced to explain some of the diversity findings in this paper. *Structuralism and Social Support Theory* represents the theoretical underpinning upon which this qualitative research is based.

Structural theorists purport that based on need, organisms (women and minorities) respond to fill gaps in their environment. It further posits that people do not work in a vacuum but rather seek to fill in positions based on societal need and their potential offering (Milem, 1997). That is, people fill in gaps where needed. In engineering, one application of structuralism suggests that specifically women but also minorities are often discouraged by teachers and counselors from taking math and science courses integral for majoring in engineering. These groups are often steered toward more traditional social science courses. Citing, there may be fewer job opportunities in engineering and more viable career paths in the social sciences (McLoughlin, 2005). As structuralism suggests, necessity is oftentimes the impetus under which paradigmatic shifts occur.

Vincent Tinto's Social Support Theory (1993) hypothesizes that the existence of social supports and positive social relationships in an institution is integral to maintaining and advancing the students' success (Milem, 1997). A growing body of research supports his views and further contends that on-campus support, including relationships with classmates and faculty; contribute to academic success, social satisfaction and college completion among Black undergraduates (Moreno, et. al 1999). Despite their discomfort with the subject matter, students shared their experiences about diversity in their engineering programs and the impact it had on their educational experiences. Many women and ethnic minorities highlighted their potential unique contributions to society through engineering.

METHODOLOGY

Data were collected as part of a larger study of engineering undergraduate students from four distinct U.S. Universities whom initially enrolled during the 2003-2004 academic year. For the purpose of this study we have ascribed pseudonyms to each institution: A) Technical Public Institution (TPI), a public mid-western university specializing in teaching engineering and technology; B) Urban Private University (UPU), a private Historically Black University mid-Atlantic institution; C) Large Public University (LPU), a large public university in the Northwest U.S.; and D) Suburban Private University (SPU), a medium-sized private university on the West Coast.

This mixed method study, investigates experiences of a single cohort of undergraduate engineering students over 4 years and in their own voices. Quantitative and qualitative findings from 94 structured interviews conducted during the spring semesters of their sophomore year are presented in this paper. The close ended responses generated from the interviews were analyzed by using descriptive and inferential statistics. The open ended responses were coded and searched for patterns disaggregated primarily along the lines of gender, ethnicity and institution. No predisposed definition of diversity was expressed or implied while conducting the research or analysis. When diversity is discussed in this paper, it reflects a non-scripted, but inductively constructed term based on the responses of the sample. The quantitative method gives way to the theoretical limitations that suggest that research only uncovers differences but does not answer questions steeped in research methodology that employ both qualitative and quantitative methodologies.

MAJOR FINDINGS

In response to the research questions, the major findings of this study are divided into four primary categories in an effort to be brief: *Defining Diversity*; *Academic Diversity*; *Gender Roles and Identity*; and *Racial Identity*.

Defining Diversity

Students defined diversity in many ways. Some familiar themes included diversity of gender, race, cultural, and ideology. Definitions were as varied as students' levels of comfort. For example, Peter, defined diversity by saying "...I think diversity means people coming from different cultures...it's a difference." Some students from SPU found it more challenging to define diversity. Laughing or chuckling during their comments was common, exposing a level of discomfort with discussing diversity. Roy, like many others define diversity by sharing "...ah, diversity means ah, it means, ah, it's hard to define diversity without diversity (chuckle)." Bob and other students from LPU found defining diversity monotonous and redundant Bob cited, "...social diversity ...is pounded into our head at every stage of your development..." Rick said, "...diversity is one of those 'buzz words'. I don't think it's as important as everyone tries to make it." Further, Richard shared "...diversity...I think that's the fourth time I've heard it this year (laughing)...so I guess diversity is just a bunch of different personalities all in one together." In their own words, students outlined an impending generational paradigm shift in diversity. Seemingly diversity has become more of a catch all phrase.

Academic Diversity

Students were asked to rate their institution's level of diversity and explain why they provided that particular rating. Findings varied within and between participants with interesting inconsistencies in ratings and explanations. Most students rated their schools as "diverse" (mean rating of 3.32 on a 0-4 scale, where 0 = not at all diverse and 4 = very diverse). Ironically, those students who struggled most to define what diversity meant to them, rated their school highest on the diversity scale. Interestingly, there were some inconsistencies in what students reported quantitatively and what they went on to describe qualitatively. That is sometimes their ratings of very diverse, or diverse were inconsistent with their follow-up descriptions. Consider Tom, from LPU, for example. When asked, "How would you rate your schools level of diversity, Tom said, "... I would say it's fairly diverse." When probed as to why, Tom replied, "It's a large school so there's definitely going to be a difference of opinion. There was evidence of that just today in the [my school] lounge...college republicans are protesting...they're protesting... admission based on race...now there are these other groups... coming out and sort of doing a counter-protest...I think the school tends to lean more one way than the other. I think like the college republicans tend to be more in the minority..." Also key is that students often define their academic institutions within the predictable range of how society might label their institution in reference to diverse composition.

Gender Roles and Identity

Female and male students shared differing opinions about the impact that gender has on their becoming an engineer. Almost two thirds (63%) of students said that their gender

did not affect their views of becoming an engineer. Female students that did state that gender has an effect on becoming an engineer acknowledge the existence of organizations that support women. Lisa, a white student from SPU said it best, "...there are societies, like Society for Women Engineers...that does help change our perspective on being an engineer ...it's 'cause I'm female, because I'm a minority and I'm not used to being like that because I'm a white middle class individual ... it's hard to become an engineer, it's real intimidating to be...working for... predominantly all males...it's kind of a challenge to me, ...I can do this, I can pioneer this and be a female engineer, be just as good as a male engineer." Similarly, male students are equally as vocal about the role gender plays in getting their engineering degree. Some express resentment to policies in place to support women and minorities. For example Martin, from LPU exclaimed, "...if the females... have an advantage, just because things like affirmative action, you know where they give certain advantages to some minorities, I wonder if it is a disadvantage being the majority?" Finally, when asked about how their gender affects their views of becoming an engineer often individuals shared honest, yet poignant adages reflective of a foregone past. For example, Henry, from SPU, exclaimed, "...It's more natural for males to be engineers." Although sophomores in this study shared that they felt both flattered and hindered by gender, they all reported being prepared to perform in the field of engineering. Not surprisingly, one of the biggest gaps for women shows up in the lack of role models present.

Racial Identity

Students shared views about how they believed their racial identity affected their views of becoming an engineer. 81% answered "no," that race had no impact on their engineering aspirations. Joel, a white student from LPU articulates, "I really don't think so. I don't think that is a big deal. I don't think about it very much." Yet, Nathan, an African American from UPU, found it more of a concern. He details, "...The only thing it affects is who's gonna employ me...but it doesn't affect how I feel about being capable...if you know what I'm saying, because I'm black...." Carlos, a Hispanic student offered a reflection about how race impacts his becoming an engineer. He exclaims "...No, maybe if I was like another race...people still tell me I look white...my being Spanish has in ...no way shape or form [affected] anything...so I don't celebrate Cinco de Mayo or anything...." Certain ethnic groups felt a social responsibility or pressure to pursue a degree in engineering. Eddie, a sophomore from TPI, shared: "...I don't see my race being a huge... factor in being an engineer, but...I think that at times since I'm Asian, that I fall into the stereotype of being a smart Asian sometimes, so I think, in that aspect it kind of ... influences, but it doesn't mean that that's all that defines why I'm planning to study engineering." As the multicultural landscape continues to broaden, racial identity is also a term that must be operationalized and not generalized for discussion among engineering academicians to incorporate in the teaching and learning process.

RECOMMENDATIONS

Finally, when studying issues with such paucity as diversity, researchers must consider employing both qualitative and quantitative methods. For quantitative researchers, it may seem uncomfortable to focus attention on the outliers that emerge from the findings, rather than focusing on the majority⁸. However it is the voices of such outliers that normally are lost in aggregated statistical analyses and remain unheard. Because of its complex factors

and sensitive nature, the empirical study of diversity has inherent challenges. Factors such as operationalizing and level of comfort with the subject thwart researchers and participants alike who often express discomfort when talking candidly about issues related to diversity. To that end, researchers must continue to develop more reliable constructs that empirically measure cross-cutting issues of diversity that can be adapted to the engineering academy. With further longitudinal analysis, we would like to examine if maturation of time impacted students' perspectives of diversity and the complexities of their identity in engineering education.

PROJECT SUPPORT

This material is based on work supported by the National Science Foundation under Grant No.ESI-0227558, which funds the Center for the Advancement of Engineering Education (CAEE).

References:

Chubin, D., G.S. May, and E.L. Babco, (2005). Diversifying the Engineering Workforce, *Journal of Engineering Education*, 94(1) 73-86.

Foor, C., Walden, S. and Trytten, D. (2007). I Wish that I Belonged More in this Whole Engineering Group: Achieving Individual Diversity. *Journal of Engineering Education*, 96(2) 103-115.

French, B.F., Immekus, J.C., Oakes, William, C.O. (2005). An examination of indicators of engineering students' success and persistence. *Journal of Engineering Education*, 94, 419-425.

Haden, C. (2007). Evaluating Support for Underrepresented Students in Engineering Degree Programs. *Proceedings, 2007 American Society for Engineering Education Annual Conference and Exposition*, Honolulu, HI.

Maple, S. and F. Stage (1991). Influences on the choice of math/science major by ethnicity. *American Educational Research Journal*, 28(1) 37-60.

May, G.S. and D.E. Chubin, (2003). A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education*, 92(1) 27-38.

McLoughlin, L. A. (2005). Spotlighting: Emergent gender bias in undergraduate engineering education. *Journal of Engineering Education*, 94(4) 373-381.

Milem, J. (1997). A modified model of college student persistence: Exploring the relationship between Astin's theory of involvement and Tinto's theory of student departure. *Journal of College Student Development*. Retrieved from the World Wide Web on January 13, 2008. http://findarticles.com/p/articles/mi_qa3752/is_199707/ai_n8776622.

Moreno, S. E., Muller, C., Asera, R., Wyatt, L., Epperson, J. (1999). Supporting minority mathematics achievement: The emerging scholars program at The University of Texas at Austin. *Journal of Women and Minorities in Science and Engineering* 5 53-66.

National Science Foundation (2002). Retrieved from the World Wide Web on January 13, 2008. <http://128.150.4.107/statistics>.