Learning from Pell-Eligible Engineering Students' Class Standpoint

Dr. Coleen Carrigan, Cal Poly San Luis Obispo

Professor Coleen Carrigan is a feminist anthropologist and an Assistant Professor of Gender, Race, Culture, Science and Technology at Cal Poly San Luis Obispo. She investigates the historical and cultural dimensions of underrepresented groups' participation in science, technology and engineering and the reasons why white males still dominate these fields.

Prof. Eve A. Riskin, University of Washington

Eve Riskin received her BS degree in Electrical Engineering from M.I.T. and her graduate degrees in EE from Stanford. Since 1990, she has been in the EE Department at the University of Washington where she is now Associate Dean of Diversity and Access in the College of Engineering, Professor of Electrical Engineering and Director of the ADVANCE Center for Institutional Change. With ADVANCE, she works on mentoring and leadership development programs for women faculty in SEM. Her research interests include image compression and image processing, with a focus on developing video compression algorithms to allow for cell-phone transmission of American Sign Language. She was awarded a National Science Foundation Young Investigator Award, a Sloan Research Fellowship, the 2006 WEPAN University Change Agent award, the 2006 Hewlett-Packard Harriett B. Rigas Award, and the 2007 University of Washington David B. Thorud Leadership Award. She is a Fellow of the IEEE.

Dr. Jim L Borgford-Parnell, University of Washington

Dr. Jim Borgford-Parnell is Associate Director and Instructional Consultant at the Center for Engineering Learning & Teaching at the University of Washington. He taught design, education-research methods, and adult and higher education theory and pedagogy courses for over 30 years. He has been involved in instructional development for 18 years, and currently does both research and instructional development in engineering education. Jim has taught courses on the development of reflective teaching practices, and has presented workshops on learning how to learn and developing metacognitive awareness. He has published and presented on engineering design, engineering pedagogies, and instructional development topics.

Ms. Priti N Mody-Pan, University of Washington

Priti N. Mody-Pan is the Deputy Director and Director of Evaluation at the Center for Workforce Development. She leads program evaluations, develops proposals and new contracts, and conducts research on diversity in science and engineering. Ms. Mody-Pan received her Master of Public Administration (MPA) and Master of Arts in International Studies (MAIS) degrees from the University of Washington and her BA in Political Science and East Asian Studies at Washington University in St. Louis.

Ms. Dawn Wiggin, University of Washington

DAWN WIGGIN BIOGRAPHICAL SKETCH

Dawn Wiggin is the Associate Director of Diversity & Access for Student Academic Services (SAS) at the University of Washington, College of Engineering. Dawn is responsible for overseeing the College's recruitment, outreach, and diversity initiatives including the recruitment and inclusion of educationally and economically disadvantaged students in order to increase the percentage of underrepresented minorities and women considering higher education in engineering.

Professional Preparation

University of Washington 2011 MPA Public Administration University of Washington 2001 BA Psychology Costa Rica Language Institute 2002 Spanish

Appointments Associate Director of Diversity & Access, Student Academic Services, University of Washington College of Engineering, Box 352180 Seattle, WA 98195-2180 (2014-Present)

Associate Director of Recruitment & Outreach, Student Academic Services, University of Washington College of Engineering, Box 352180 Seattle, WA 98195-2180 (2011-2014)

Associate Director of Experiential Learning, Student Academic Services, University of Washington College of Engineering, Box 352180 Seattle, WA 98195-2180 (2009-2010)

Program Manager, Engineering Co-op & Internship Program, Engineering Advising & Diversity Center, University of Washington College of Engineering, Box 352180 Seattle, WA 98195-2180 (2005-2009)

Program Coordinator, Engineering Co-op & Internship Program, Diversity & Student Services, University of Washington College of Engineering, Box 352180 Seattle, WA 98195-2180 (2003-2005)

Publication

Jeremy Kingma, Eve Riskin, John Schneider, Robert Olsen, Sonya Cunningham, Dawn Wiggin, Kirk Reinkens, and Scott Winter, "The Washington STate Academic RedShirt (STARS) in Engineering Program," Proceedings of the 2014 American Society for Engineering Education Annual Conference, June 2014.

Synergistic Activities & Projects in Education

Co-Principal Investigator, Washington STate Academic RedShirt Program (STARS). Grant increases the retention rate of economically and educationally disadvantaged students in Engineering, (2013-present).

Principal Investigator, Early Engineering Institute. Grant increases the math aptitude and interest in engineering for 144 middle and high school students from rural Washington communities, (Summers 2012-present).

Affiliate Associate Director, NSF Research Experience & Mentoring. Grant provides funding for six incoming UW freshmen to conduct research on the "Towards zero-energy buildings based on energy-harvesting electrochromic window (EH-ECW) and thermoelectrics (TE) systems" project, (2012-present).

Associate Director, Mathematics Academy. Program creates access to engineering for educationally and economically disadvantaged students, (2011-2014).

Associate Director, Engineering Discovery Days. The largest UW College of Engineering annual event brings over 8,000 students and families to campus to explore engineering through interactive activities, (2012-2014).

Board President, NW Career Educators and Employers Association. Organization brings together career educators and employers to improve the economic vitality of the Pacific Northwest, (2008).

Collaborators

Dr. Robert G. Olsen, Professor of Electrical and Computer Engineering, Washington State University Dr. John Schneider, Associate Dean of Engineering and Architecture and Professor of Electrical and Computer Engineering, Washington State University Kirk Reinkens, Instructor, Recruitment & Retention Coordinator, Washington State University

Ms. Sonya Cunningham, University of Washington

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I. Introduction

Diversifying the field of engineering is an on-going challenge. Supporting and advancing underrepresented students requires developing and refining targeted outreach, recruitment, support, and academic services for all students. To ensure inclusivity in diversity outreach efforts, we must ask ourselves, "Is higher education serving the higher good?" and "Who are we missing – who is still underserved by our policies and programs?" A report, sponsored by the Jack Kent Cooke Foundation, identified students from lower socioeconomic backgrounds as a vulnerable group with significantly lower rates of degree completion in higher education.[1] Our qualitative research was motivated by the belief that attention to students' income standpoint is critical to ensuring engineering is inclusive. Prioritizing class diversity in engineering education may expedite the end of inequitable practices and outcomes that reproduce systemic inequalities along class lines.[2]

To begin this study, we asked: "How are low income students faring in engineering majors?" This question inspired our comparative analysis. At a large public university, we compared students who were Pell-eligible with students who were not. Our data demonstrated that both the rates of acceptance into an engineering major and graduation rates are significantly lower for Pell-eligible students. In fact, being Pell-eligible decreases an individual's odds of getting into engineering by almost 25%. To understand this disparity, we designed our action-oriented study to investigate the interpersonal, community, and institutional experiences of low-income students in engineering majors. Our goal is to inform efforts to remedy the achievement gap between low and high-income students in engineering and identify effective practices for cultural change.

In this paper, we explore college experiences of engineering students of non-dominant class backgrounds to determine their experiences in earning engineering degrees; the challenges and opportunities they encounter; and their personal attributes that enable their success. Our action-oriented research asked: **What constraints and opportunities do Pell-eligible students face in order to major in engineering fields? Are there special attributes that allow Pell-eligible students to succeed in engineering and can these attributes be cultivated?**

II. Theoretical Framework

Our study presupposes that both students from lower and higher socioeconomic backgrounds have valuable knowledge and abilities gleaned from their social standpoint. Too often, engineering education can reward those with class knowledge common in dominant classes in the US and, too often, can squander opportunities to value and nurture the navigational capital of students from less privileged backgrounds. To better understand these power relations and the cultural landscape through which our participants navigate, we rely on critical race theory and its method of analyzing everyday interactions as the means of reproducing systemic, historic inequalities. Yosso, a critical race theorist, calls the class knowledge of students from underprivileged backgrounds "navigational capital," which is the ability to navigate institutions that operates with dominant socioeconomic standpoint in mind.[3] Stephens, Hamedani and Destin

argue that students from lower socioeconomic backgrounds demonstrate a greater capacity for *interdependent* thinking, whereas universities encourage and reward the *independent* thinking more commonly associated with of the standpoint of students from dominant groups.[4] The theory of navigation capital presupposes that both students from lower and higher socioeconomic backgrounds have valuable knowledge and abilities gleaned from their social standpoint. We employ this conceptual framework to highlight this unique attribute of students from lower socioeconomic backgrounds so that institutions of engineering education can actively cultivate and reward this type of class knowledge.

Navigational capital is an understudied, less understood form of capital.[5] It enables students to sustain high achievement despite obstacles that stress students and test their persistence.[3] This theory is a protest against "deficit theorizing," research that assumes that institutions of higher education are fair and equitable, and underprivileged students, their parents and communities need to learn "appropriate" skills and knowledge to earn secondary degrees.[3] In other words, deficit thinking leads to the erroneous conclusion that individual students need to be fixed and institutional systems like academia may remain unchanged. Our goal in this research is similar to the goal of the NSF ADVANCE program, which is to "fix the system" not "fix the women."[6]

Our study contributes to understandings of navigational capital by illuminating how Pell-eligible students glean non-traditional resources from their lives and use them to navigate institutions of higher education in successful pursuit of engineering degrees.

III. Methods

With change agency in mind, our research was designed and conducted as "action research," aimed at making the lives of the dispossessed visible as well as uncovering systems of disempowerment and injustice.[7, 8] Combining diagnosis and collective reflective inquiry, we focus on practical issues identified by our student participants. Our goal is not only to ameliorate problematic social conditions for individuals but also to change the culture of the institutions to which they belong.[9] This approach was inspired by the National Science Foundation ADVANCE program, which was designed to not only help individual female scientists and engineers navigate institutions of knowledge production, but also to transform STEM fields at a systemic level.[6] Toward this end, this research seeks to illuminate the reproduction of class inequalities in engineering higher education from the perspectives and experiences of Pell-eligible students.

Although there are different ways to assess students' socioeconomic status, parents' income and education level are strong indicators.[10] We chose Pell Grant status as a proxy for lower income because it signals financial need and is readily recognizable on students' records.[11]

Our qualitative data were collected from September 2012 to July 2013. We sent invitations to participate to all Pell-Eligible engineering students and offered a forty-dollar incentive for participation; 32 students responded. Women had higher volunteer rates for this study, and among the men, there were more volunteers from underrepresented minority backgrounds. We selected participants based on availability and made an effort to achieve variety in regards to gender, race, and engineering disciplines. The primary data collection method for this study were eighteen, hour-long, semi-structured interviews with Pell-eligible

engineering students at a large public university. To investigate the questions driving this research, students were asked how they came to choose engineering as a major, what supported their goals of earning a degree in engineering and what thwarted their ambitions.

Our participants included ten women and eight men. Participants were given a pseudonym to insure their anonymity. Four of our participants are African Americans, four are Asian or Asian American, two are Indian American, two are Latina/o, one is a Pacific Islander and five are European American. Participants were sophomores, juniors and seniors. Nine engineering majors are represented in this study, including: Materials Science and Engineering, Mechanical Engineering, Electrical Engineering, Aeronautical and Astronautical Engineering, Computer Science and Engineering, Civil Engineering, Industrial Engineering, and two other engineering disciplines.

We analyzed our data to develop a fuller understanding of Pell-eligible students' experiences in engineering undergraduate education with the goal of identifying and transforming social inequalities in engineering educational practices and institutions. The first and second authors began open coding the data, looking for meaning and variations in meaning. After coding ten interviews, we had created eleven domain categories and the majority of the categorical themes. Because our study included a very specific population and had narrow objectives of discovery, we posited we had reached data saturation after 18 interviews. Next, we began closed coding, and memo-ing collaboratively, with all authors participating. In choosing which themes to highlight, we drew on our group's professional and leadership experiences, skills, and observations to triangulate our data.

IV. Findings

1. Support

Our research illuminates new information about what supports specifically engineering students from low-income backgrounds. First, our participants, all of whom were persisting in engineering majors at the time of this study, expressed high levels of self-efficacy, and self-identified as someone who seizes opportunities and combats self-doubt with a fierce work ethic. We call this type of student an "active agent." Second, emerging across all domain categories was a strong sense of responsibility toward kin, and community and support from these oftentimes-nontraditional sources. In identifying and analyzing these two seemingly contradictory characteristics – strong individual drive and interdependent, relational orientation – we hope to inform diversity advocates in engineering about the unique attributes that help students from low socioeconomic standpoints persist and how these attributes can be nurtured by institutional interventions.

Anisa, a Materials Science and Engineering student and George, a Mechanical Engineering student, possessed the qualities of "active agents," a term we coined to describe engineering students who are both individually driven and spurred to success by their social standpoints. In their interviews, they offered striking insights into active agents' motivations to succeed in engineering higher education. Anisa claimed that she stole her education:

> Anisa: Engineering was not a choice given to me. It was something I had to reach for and steal.
> Interviewer: Why do you say "steal"?
> Anisa: I felt like the engineering field – all these sciences, didn't fit into my culture… It's like something that I had to go and reach out and grab for myself. It wasn't something that was handed to me on a silver platter.

Harney and Moten's discussion of marginalized groups in education is helpful in interpreting Anisa's description of her learning opportunities. Inspired by Pistol, the trickster character in Shakespeare's *Henry V*, the authors claimed that "the only possible relationship to the American university" for marginalized group members is to sneak in and steal what one can.[12] In a similar vein, feminist scholar Mary Daly described her scholarship as a form of piracy, stealing knowledge from dominant groups and distributing to disadvantaged populations for liberatory purposes.[13] Anisa's defiant attitude toward engineering education and the descriptors in her narrative, for example "silver platter," suggest she was cognizant of her class standpoint and it had influenced her personal resources for succeeding in engineering.

When asked what motivates and sustains her in engineering, Anisa credited the cultural "tools" of her parents' support. "I didn't assimilate…I changed things around to fit me…my mom and my dad gave me the tools." Anisa uses these tools to change "all these sciences …[to]… fit into my culture." These tools are not part of the class knowledge inherited by high socioeconomic status students, but nonetheless, a valuable form of knowledge that bolsters Anisa's drive to earn a Material Science Engineering degree. Anisa refrained from framing her struggle as one of personal deficiency. She did not fix herself; she found a way to make the system work for her.

George had a different perspective on his educational trajectory, but one no less strategic and intentional than Anisa's. He reflected:

> Moving through my academic career, regardless of my home or financial standings, that compassion and support for who I am as an individual without sacrificing what I want to do or what I want to pursue has helped guide and shift me and shaped me in a way that allowed me to pursue education…I think that's something that I try to give to others – compassion – and that's important – is a defining characteristic of what got me to stay in [engineering].

Compassion and a desire to give to others bolsters George's will to persist in engineering. George's narrative provides a perspective on a student's aspirations forged within a social context that requires relational thinking and approaches. Our study found that our participant relational orientations sprung from their wide-range of support networks. Parents' support can be one important element to engineering student's persistence, but so too can be the support of community members, extended family, friends, and educators willing to offer encouragement, advice, resources, guidance and comfort. This support can be important to all students but is especially critical to lower income students' persistence in engineering. For example, George moved in with his high school mentor:

> I moved in with Derek and it provided me the stability and support to understand how to apply to college; how to build myself into a competitive applicant, and how to look for what I want in a college. I no longer had to worry about the responsibility of who I was, and how I was going to take care of myself, or how I was going to contribute back to taking care of my family. The only thing I had to worry about was being the student.

George's mentor offered him the opportunity to pursue engineering education on a more level playing field with his higher socioeconomic standpoint peers. It meant that George did not have to participate in the workforce while a student and was free from significant domestic care responsibilities.

2. Challenges

A significant finding of this research is participants' cognizance of their class standpoint and how their economic status put them at an institutional disadvantage. Doreen connected her low socioeconomic standpoint to her educational opportunities:

> There was like one guy in my high school, he's at MIT right now. He and I were considered like on-par with each other in school-wise, activity-wise, all that kind of stuff. But it's just he had different resources than I did. I always kind of wondered if I fit in with that crowd a little bit more where I would be now.

Doreen's class standpoint impacted the kinds of resources available to her and created her impression that she did not fit in with other engineering students from more privileged backgrounds. The effects of inequitable resources and exclusionary cultures can exacerbate other long-standing practices that privilege high-income students. For example, engineering education is known for its rigorous curriculum, intense time commitment, competitive ethos and "weed-out" mentality.[14] This puts students with time commitments outside of school at a disadvantage.

Some of our participants had to not only work to earn a paycheck but also to perform significant unpaid labor in the home caring for kin. For example, Kristy, an Aeronautical and Astronautical major, took primary care responsibility for her siblings and extended family. "I took my sister. I took my brother. Actually," she recalled, "I also took a cousin. ….my cousin lived with me for a couple of years too." Anisa, the Materials Science and Engineering student quoted above, was the parent of a toddler. These types of labor responsibilities conflict with the current design of competitive engineering education programs and can lead to higher attrition for Pell-eligible students.

Discussion

We need to know more about lower socioeconomic standpoint students' experiences and how institutions of engineering education can better support their persistence in engineering majors. Anisa's description of her engineering education as something she had to steal begs the question: What kind of interventions can interrupt the educational practices that turn economic privilege into merit and success, practices that betray higher education's commitment to social justice? In this paper, we adapted the concept of navigational capital from critical race theory to

qualitatively explore engineering education as experienced by students from low socioeconomic standpoints at a large public university. Our finding suggest that students from low socioeconomic standpoints who succeed in engineering majors are cognizant of their class standpoint and the barriers this poses to their educational trajectory. They persist to maneuver through institutions that are seemingly indifferent, or even hostile, to them and earn an engineering degree. Navigational capital enabled our participants to be active agents who endeavored to succeed in engineering despite their lack of privilege. A component of navigation capital that our participants' stories illuminated was their ability to approach their education from both independent and interdependent perspectives, a flexibility that may improve the social contributions engineers make to this world. Finally, non-traditional sources of support help mitigate the disadvantages students with less affluence face.

The result of our research is a challenge to deficit theorizing, which essentially amounts to encouraging underrepresented groups to "bootstrap," or leverage their "meager capital."[15] Instead, this research reveals that class knowledge is important even if it doesn't stem from the upper class. Understanding the important and unique skills and knowledge low-income students bring to engineering should inspire engineering educators to try to level the playing field so students from all class standpoints can contribute to the engineering profession.

Recommendations

Our participants were most constrained by financial considerations; time deficits related to labor in the workforce or their households; and the difficulty of finding appropriate and supportive resources in their college and departments. These experiences illuminate unexamined, institutional assumptions that engineering students have financial stability, short commutes, few responsibilities outside of schoolwork, and the savvy to navigate institutional systems on their own. These assumptions must be reexamined.

What can institutions of engineering higher education offer students from less affluent class standpoints? Stephens, Hamedani and Destin's 2014 study demonstrated that acknowledging and discussing the impact of students' social class backgrounds on their college experiences proved effective at improving low-income students' networking skills and grade point averages.[4] In other words, change agents in higher education may begin to diminish the class achievement gap in by publicly acknowledging how class informs students' educational experience.[4] Therefore, we argue that the first step to cultivating Pell-eligible students' special attributes is to openly engage in dialogue with students about the importance of their class standpoint and the benefits of navigational capital. Second, we recommend diversity advocates in engineering design programs that buttress lower income students' community networks and non-traditional sources of support. Third, we suggest dispelling current assumption in engineering education that engineering students are without significant time commitments in the workforce, home or daily commute. There is little slack in engineering education, so a single hardship in a student's life can derail a promising career. Many of our participants were dealing with multiple hardships and constraints. Finally, participants had both strong praise and criticism for college and department outreach program and advising services. On one hand, participants complained that some advising services were discouraging and unsupportive. Complaints were made by both female and male participants but referred to engineering departments that have the greatest

overrepresentation of students from dominant groups. More research is needed to explore this correlation. On the other hand, Doreen, for example, said she loved her department advisor: "Everyone says that she's a really good advisor and very communal." Schools would do well to pay careful attention to the values and practices of their outreach and advising services, encouraging inclusivity rather than exclusionary, "weed-out" attitudes.

Schools interested in taking steps to improving Pell-eligible students' experiences may consider adopting the recommended strategies outlined above. Not only may they benefit individual students, especially those without economic privilege, they may help broaden the participation of groups from a greater range of class standpoints, thereby enriching the engineering community and its ability to find more just solutions to problems in an increasingly complex world. More research is needed to further understand the extent to which other groups have similar or different experiences than Pell-eligible students, the impact of multiple underrepresented social identities on persistence in engineering, and the differences between Pell-eligible students who persist in engineering and those who do not. Finally, measuring the impact of a greater participation of Pell-eligible students on the racial and ethnic diversity of engineering student populations may also deepen our understanding of underrepresented students' path to success and the associated institutional strategies of support.

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