WIP: A Case for Disaggregating Demographic Data

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Adam Kirn is an Assistant Professor of Engineering Education at University of Nevada, Reno. His research focuses on the interactions between engineering cultures, student motivation, and their learning experiences. His projects involve the study of student perceptions, beliefs and attitudes towards becoming engineers, their problem solving processes, and cultural fit. His education includes a B.S. in Biomedical Engineering from Rose-Hulman Institute of Technology, a M.S. in Bioengineering and Ph.D. in Engineering and Science Education from Clemson University.

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Cheryl Cass is a teaching associate professor in the Department of Materials Science and Engineering at North Carolina State University where she has served as the Director of Undergraduate Programs since 2011. Her research focuses on the intersection of science and engineering identity in post-secondary and graduate level programs.
This Work In Progress (WIP) paper presents the argument that researchers need to guard against an assumption of homogeneity within demographic groups. As research in engineering education is conducted, differences between demographic groups (e.g., race/ethnicity, gender) are often noted as meaningful moderators of outcomes (e.g., performance, belonging). However, we argue that researchers must look at intersectional identities to uncover distinctions that would otherwise go uninvestigated. We argue disaggregation of demographic groups is a useful tool to investigate intersectional identities. Disaggregation and intersectionality research focused on undergraduate engineering students’ race/ethnicity and gender is being conducted, and we will extend it to include graduate engineering students and investigate diversity beyond race/ethnicity and gender. We are interested in how disaggregation and intersectionality can assist in investigation of differences in engineering identity. We hypothesize that investigation of intersectional identities through disaggregation of traditionally studied demographic groups will promote a more nuanced understanding of the engineering identity and experiences of understudied graduate engineering students. Therefore, this research is guided by the question, “How can we disaggregate engineering graduate student demographic data to quantitatively evaluate engineering identity development in understudied groups?”

Disaggregation and Intersectionality
Disaggregation is the idea that meaningful information can be found by looking at more targeted groups of people. That is to say, disaggregating a large demographic group such as breaking down the category of women to look at race differences between women (e.g., Latina women vs. Black women) or the category of ‘Asian’ to look at the differences between Asian countries (e.g., China vs. Japan vs. India) can demonstrate meaningful distinctions between subgroups. In this way, disaggregation is a useful tool to look at the intersections of identities or demographic groups. Intersectionality is the concept that multiple minority identities intersect with each other to multiply identity-focused experiences, which may be a direct result of structural or cultural inequalities [1]. For example, differences in race/ethnicity, gender and sexual identity -- or combinations of the three -- change the experiences and perceptions of students (see Figure 1). For example, a Latina lesbian has meaningfully different experiences compared to a heterosexual Latina, who in-turn has different experiences from a heterosexual White woman.

A paradigm shift in how underrepresented groups are studied can benefit engineering education by simultaneously looking at identities beyond race/ethnicity and gender to include what Núñez describes as a multilevel intersectionality approach [2]. Investigation of intersectional identities may prove useful in conceptualizing the different ways in which diverse students experience engineering education. When we can better understand the lived experiences of students, engineering education will have the opportunity to address concerns, conflicts, and negative environments, which lead students to leave the field. To accomplish this, engineering education research can disaggregate gender and race to better understand minority persistence in engineering [3].
In addition to gender and race/ethnicity intersections, we will investigate the intersections of sexual and gender minorities in their experiences of engineering education and engineering identity. In engineering, investigations of sexual and gender minority experiences are rare [4]. Some research shows sexual identity minorities experience barriers to professional identity development [5]. Recently, categories such as first generation students, socioeconomic background, and ability have been used to point to other potentially meaningful intersections of personal identity and engineering identity [6, 7]. Here, we will use an intersectional lens to explore the differences in engineering identity and graduate academic experiences of racial/ethnic groups, women, and lesbian, gay, bisexual, transgender, asexual (LGBTQA) graduate engineering students. Exploring how intersectional identities effect engineering identity development may provide an opportunity to uncover new information in the continued disparity of women, racial/ethnic minorities, and LGBTQA people in engineering.

Undergraduate Literature
Existing research in intersectionality focuses on undergraduate engineering students and uses gender and race as the primary intersectional identities [8]. While we are focused on graduate engineering students, literature on engineering graduate students is limited [9-15]. Therefore, our research uses literature on undergraduate students as a starting point for both intersectionality and engineering identity. Many studies aggregate minority students due to the low number of participants into one ‘minority’ group [3]. Further, many focus on gender or race/ethnicity separately without exploring the intersections of gender and race [8].

The intersection of minority identities may create unique experiences beyond any one minority identity. While intersectionality research has been utilized in qualitative explorations of identity in engineering [16, 7], some notable quantitative exceptions can also be found. Ro & Loya utilize an intersectional lens to demonstrate that gender and race should be analyzed together (i.e., Black women vs. Black men) rather than as distinct variables by demonstrating differences in self-assessment of engineering and professional skills [8]. Similarly, Lord et al., found that by disaggregating gender and race, the student experience can be more accurately described [3]. Godwin and colleagues explore the intersection of race and ethnicity in chemical engineering.
undergraduate students to show significant differences in belongingness, motivation, and STEM identity measures for racial majority women and racial minority women [17]. In introducing the research, the authors are explicit in acknowledging their analysis is limited to race and gender and is unable to investigate other intersections due to limited sample sizes [17]. When intersectional identities are studied by disaggregation of demographic groups, a deeper understanding of the lived experiences and challenges students experience can be better addressed. Further, Ro & Loya call for the support of diverse students in engineering programs through investigation of their needs and consideration of their intersectional identities [8]. Here, we not only support this call, but extend it to include graduate engineering students and the support of diversity beyond race/ethnicity and gender. A similar exploration of disaggregated and intersectional identities may be useful in conceptualizing engineering graduate student experiences, especially if additional demographic categories can be used to uncover deeper meaning in intersectional identities.

**Engineering Identity**

Engineering identity is how one sees oneself as an engineer and has been shown to be a predictor of perseverance and performance in engineering programs [18-21]. Engineering identity is becoming a common concept for understanding how undergraduate students become successful engineers. Performance/competence, interest, and recognition have been identified as key components of engineering identity for undergraduate students [19]. Graduate engineering identity is beginning to be explored, including how it is similar to undergraduate engineering identity [9-12]. This research attempts to explore potential differences in the experiences of engineering graduate students by looking at the intersections of identities while comparing the strength of students’ engineering identity.

**Current Research and Data Collection**

This work is part of a larger mixed-methods study in which we are examining the experiences of engineering graduate students in the context of identity and motivation frameworks. We will utilize data from a large national survey of engineering graduate students to demonstrate examples of meaningful disaggregation of demographic groups. Demographic information is collected in accordance with best practices to collect a comprehensive range of demographic data [22]. The survey instrument, which contains Likert-type measures of graduate students’ future-time perspectives, identity-based motivations, identities, and academic experiences, was piloted at two institutions (large southeastern and large western), garnering nearly 350 responses. Exploratory and confirmatory factor analyses were used to uncover the factor structures of the items as well as to assist in the item cutting process and achieve a 15 minute survey [23]. The survey is being deployed nationally to a representative sample of engineering students based on state, program type (e.g., electrical engineering, mechanical engineering, etc.) and program size (i.e., number of Ph.D.s awarded per year). A master list of 1382 Ph.D. engineering programs from ASEE was coded by state, the number of engineering Ph.D.s granted in 2014, and by type of program. A probability proportional to size sampling was used to select programs from the population for inclusion in the survey. Approximately 260 programs were selected into the first sample. Due to low response from programs in the first sample, this procedure was repeated to select two additional sets of programs. The sample plan ensures the sample is representative of
the population in terms of location, size, and program. We expect to collect at least 2500 student responses by early 2018.

Contact information for each program on the sample program list was gathered for the program chair, graduate coordinator, and other pertinent staff from program and/or university websites. Each program was emailed an initial invitation to participate. The invitation included general information about the research project and a request for the recipient to upload a list of their current engineering graduate students to a Qualtrics survey. If programs were not able to provide a list of students, they were asked to forward a survey invitation to their student listservs. Programs participated in both of these ways with a few variations for specific schools. Programs were contacted three times (twice by email and once by phone), and if no response was received, the program was replaced with a matched randomly selected program. When a list of students was provided by a program, the students were emailed directly through Qualtrics with an invitation to participate in the survey. Students were sent two reminder emails to complete the survey.

Research Questions

With the anticipated large sample size (anticipated \( n = 2500 \)), we will be able to explore demographic groups that have traditionally been aggregated due to relatively small populations of these students and small sample sizes and differences in their engineering identity. In particular, will use an intersectional lens to explore the differences in experiences of racial/ethnic groups, women, and LGBTQQA students. Results of this work will demonstrate the need for researchers to look beyond traditionally defined demographics for meaningful differences in experiences in graduate engineering education. We intend to investigate the research questions in Table 1, and would like feedback from the community on our potential research questions and the best way to use this information in practice.

| PRQ1. Does the intersection of race/ethnicity and gender influence the strength of engineering identity in graduate students? |
| PRQ2. What identities are related to stronger/weaker engineering identity? |
| PRQ3. What intersections of identities are related to stronger or weaker engineering identity? |
| PRQ4. How does engineering identity vary within majority identities? |

We hope the more complete understanding of graduate student experiences will be used to improve recruitment and retention efforts. Through a deeper and more nuanced concept of graduate engineering identities, we can better serve the diverse needs of engineering students. Knowing where current graduate engineering students struggle to mesh their personal identities with their engineering identity will highlight opportunities to engage students in new and unique ways. Whether through new programming for a more diverse student body or demonstrating a culturally sensitive environment to prospective students, understanding student identities will
provide an opportunity to advance and grow engineering education. Future research can utilize the highlighted differences within demographic groups to identify new directions for research into recruitment and retention of engineering graduate students.

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References


