



”Learning from small numbers” of underrepresented students’ stories: Discussing a method to learn about institutional structure through narrative

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Abstract

The underrepresentation of women and men of color and white women in undergraduate engineering programs continues to be cause for concern by national engineering bodies, university administrations, and disciplinary organizations. Extensive research and intervention programming has gone into understanding this underrepresentation, and why it persists despite national and institutional focus and funding. However, this paper argue that most previous studies and interventions have been hampered by three challenges: 1) they tend to depend on statistical methods of generalization to understand the experiences of underrepresented people, despite the fact that the number of such people are usually too low to make analysis of them statistically significant; 2) they often result in interventions not in the structure of institutions but in the behavior of students themselves, and in their adaptation to their institutions; and 3) they usually examine women and people of color at predominantly white educational institutions and thus fail to focus on institutions which have showed relatively better success. This study was designed to respond to each of these challenges by importing research tools designed by sociologists to examine small numbers of people to investigate institutional structure: we use personal narratives about engineering education contributed by white women and students of color in undergraduate programs to understand how the structure of their educational institutions assists or hinders their success. My team and I have confronted methodological challenges when trying to analyze these narratives using commonly used qualitative coding methods. Through describing these challenges in detail, along with our theoretical and methodological frameworks and data collection and cleaning procedures, I hope to discuss with other qualitative researchers ways to use better methods that allow us collectively to “learn from small numbers.”

Introduction

In recent decades, hundreds of educational interventions, thousands of research programs, and millions of dollars of federal funding, have addressed the underrepresentation of white women and people of color at all career levels and across all disciplines of engineering.¹ Researchers seeking to understand white women’s and people of color’s underrepresentation have explored gender and race differences in psychological constructs, cognitive skills, affective measures, and social behaviors considered relevant to students’ engineering educational success. They have striven to understand the impact of implicit bias, chilly climate, and micro-inequities on white women’s and people of color's continued low rates of entry into and comparatively high rates of exit from the engineering educational and professional “pipeline” compared to their white male colleagues. Their studies have spanned the space of gender, race, and engineering by exploring underrepresented people's relationships as young students with peers, teachers and parents, as young ethnically diverse women and men with media, role models, and career visions, as undergraduate and graduate students with teams, mentors, and technical material, and as professionals with colleagues, peer-reviewers, and institutional leaders.

While these studies have helped the engineering education enterprise make modest improvements in the numbers of white women and people of color in engineering undergraduate programs, these improvements seem to have plateaued.² The numbers of white women and people of color in engineering have not increased proportionately to the effort expended by the community. I argue that an explanation for this persistent state can be found in methodological and theoretical limitations of these studies, which, to a large extent:

- rely on statistical methods to claim generalizability, even though the numbers of white women and people of color in the study populations are usually too small to justify powerful claims to significance. The number of people of color is usually so small that researchers lump all ethnicities of color together to contrast with white populations, or say that no claims can be made about race altogether;
- provide solutions that continue to rely on moulding individuals to better fit into existing institutional structures, despite collective calls to “fix the system, not the student;”
- focus on primarily white institutions (PWIs) and neglect those institutions that successfully educate relatively large numbers of white women and people of color in engineering: women’s colleges and minority serving institutions (MSIs).

The study described in this paper addresses these limitations by importing powerful theoretical and methodological tools designed to understand gender and race in institutional context. Rather than use methods for studying large numbers of people where we do not have large numbers, it uses methods that allow researchers to “learn from small numbers.” Rather than completing group-level analyses to tell individuals how to better fit into existing institutions, it considers a small number of individual narratives in great depth to examine institutional structure as the unit of analysis. Rather than primarily studying engineering educational institutions that are relatively not successful at educating white women and people of color, it focuses on institutions that are successful, such as women’s colleges and MSIs.

In the overall research project on which this paper is based, I work to use personal narratives of people considered marginalized in engineering education undergraduate programs in the US to map out the gendered and raced structure of the broader institution of engineering education. This project’s research goal is to identify institutional-level characteristics present in post-secondary engineering educational structures that strongly support or challenge the academic success of underrepresented undergraduate students.

To meet this goal, this study addresses two research questions:

- RQ1. How do underrepresented undergraduate engineering students describe their interactions with educational institutions through personal narratives?
- RQ2. What institutional factors do these narratives reveal that affect the educational persistence and success of white women and students of color in undergraduate engineering educational institutions?

To accomplish this goal, my team and I collect and will analyze personal narratives contributed by underrepresented students situated at institutions that have histories of successfully recruiting, retaining, and graduating white women and students of color. My guiding hypothesis is that personal narratives can tell us things about gender and race that graphs cannot; as a result,

collecting and using compelling, rich personal narratives that demonstrate the complexity of underrepresented students' lives from a small number of participants will be more effective in prompting engineering education leaders to think of new ways to address institutional issues that affect underrepresented students' academic success.

This paper describes the research project's theoretical foundation, drawing on gender and race theory, Smith's idea of the "ruling relations" and Crenshaw and others' work regarding intersectionality, and both the methodological foundations and the method itself in great detail. Despite engineering education researchers' increase in interest in using qualitative methods, we often only sketch out our methods in publications due to space limitations and publication conventions. And yet, using venues such as conference papers to more explicitly detail our methods could go far to strengthen a study's "trustworthiness," (a term Robson uses in place of "validity" and "reliability" which have extensive quantitative histories³) and obtain feedback from others about the course of the research in order to develop what Sandra Harding called "strong objectivity"⁴. This paper is written in this spirit, with the hope that collectively we may together come up with novel methods that allow us to "learn from small numbers" while preserving participants' voices and stories.

Background literature and theoretical frameworks

Gender and race underrepresentation in engineering

White women and people of color remain significantly underrepresented in engineering undergraduate education in the United States compared both to college students of all disciplines and to the general population. Women earned 17.8% of all bachelor's degrees awarded in engineering in 2009, a decrease from the previous year for the 9th year in a row.⁵ African American students earned 4.6% and Hispanic students 6.6% of engineering bachelor's degrees in 2009.⁵ Table 1 presents *enrollment* data (as opposed to the *degree* data just described) disaggregated by gender and race, focusing on the underrepresented categories of most interest to the National Science Foundation. Of note is that the percentages of each non-white racial group in *engineering* are significantly smaller than those representing each group enrolled in *university*. Moreover, these dismal numbers mask the experience of women of color, who become invisible through the aggregation across race of the gender numbers, and the aggregation across gender of the race numbers. Importantly, while the numbers of women in each underrepresented racial group are startlingly small when compared to the total numbers of all engineering students (5,672 African American women, 8,470 Hispanic women, 610 Native American women, compared to 427,503 students in engineering), the proportion of women engineering students in each non-white racial group (25% of African American engineering students are women; 17.2% of Hispanic engineering students are women; 22.9% of Native American engineering students are women) is markedly higher than the proportion within engineering of either white women (16.2 of white engineering students are women) or women aggregated across races (18.2% of all engineering students are women). This study investigates undergraduate engineering students' educational experiences at the intersection of race and gender.

Other kinds of aggregation also obscure important factors. In particular, educational interventions commonly focus on underrepresentation in "STEM," where science, technology,

engineering and mathematics are combined. This masks the extent of problems in engineering, as its percentages of women and people of color are averaged with those of scientific fields like psychology and the biological sciences, which have made more progress in increasing the number of women (although less so for people of color). Moreover, despite similarities between the sciences and engineering disciplines, these disciplines also face considerable philosophical, epistemological, implementation, content, and identity differences^{6,7} and therefore require different solutions.

Table 1: Undergraduate engineering degrees awarded and enrollment in the US in 2009, disaggregated by race and gender

	Engineering undergraduates*					% of all undergraduate majors **	% U.S. population ***
	women (W)	men (M)	total	% women	% of total		
African American students	5,672	17,056	22,728	25.0	5.3	13.9	12.3
Hispanic students (domestic)	8,470	31,753	40,223	17.2	9.4	12.9	15.1
Native American students	610	2,054	2,664	22.9	0.6	1.1	0.9
White students (domestic)	40,994	212,807	253,801	16.2	59.4	63.2	74.3
Total students (incl. above groups, foreign nationals, etc.)	77,793	349,710	427,503	18.2	100	43.2% M 56.8% W	49.3% M 50.7%W

*⁵; **⁸ Fall 08; ***⁹ U.S. Census Bureau which reports 2.2% of people with multiple racial identities; ASEE does not collect such data.

Existing responses to underrepresentation

Existing interventions to address the underrepresentation of white women and people of color in engineering undergraduate education are diverse, yet follow common patterns: many attempt to provide undergraduates with tools for better negotiation of institutions by decreasing bias, increasing access, and improving fairness. An examination of recent summaries of work on gender and race helps reveal these patterns.

AAUW (formerly the American Association for University Women)’s recent summary of critical research¹⁰ on gender in STEM disciplines describes six common types of research: 1) examinations of gender-based theories of intelligence and how promotion of a “growth mindset” over a “fixed mindset” can help “protect” (p. 33) girls and women from various forms of stereotype; 2) examinations of stereotype, implicit bias, and stereotype threat; 3) studies of how self-efficacy and personal values affect occupational choice; 4) studies of how spatial skills vary by gender; 5) examinations of the relationship between major/departmental culture and curricula at the college level, and 6) studies about the impact that networking (social or formal) can play in recruiting and retaining women into STEM majors. The report recommends:

- better communication with young girls and women about all these issues: highlighting women’s achievements and students’ own skills; explaining that intellectual and spatial skills are acquired rather than innate; describing stereotype threat and implicit bias and how to overcome them; outlining clear performance expectations; demonstrating the “real life” applications of STEM knowledge; and describing means of getting support;
- better communication with peers and colleagues to enforce a culture of respect;

- more support for particular programs, such as talented and gifted programs, programs that train participants in spatial or other skills, or seminars that integrate women into departmental culture; and
- more stringent enforcement of Title IX regulations.

While this report does not cover all research on women in STEM academic contexts, it describes the most common attempts to increase the number of women in STEM disciplines. As the report makes clear, these attempts largely emphasize communication with, and training of, individual students to help them better negotiate existing educational institutions.

Regarding race, Lisa Tsui has recently reviewed parallel interventions designed to increase the number of underrepresented students of color in STEM disciplines¹¹. Tsui demonstrates that interventions tend to fall into one of 10 categories: 1) pre-college summer bridge programs, designed to help prepare students transitioning into the first undergraduate year for college-level math and science; 2) mentoring programs that coordinate various interactions and solicit people of color to serve as mentors so that underrepresented students can see role models “who look like them”; 3) undergraduate research experiences, to help increase students’ interest in scientific fields; 4) tutoring, where students who have come from schools without a rigorous college prep curriculum can “catch up” before the semester starts or “keep up” during the semester; 5) career counseling and awareness; 6) learning centers; 7) workshops and seminars to learn professional development, curricular, networking, or other professional skills; 8) academic advising to help students access cultural capital they may not have in their families; 9) financial support; and 10) “curriculum and institutional reform” focused on “teacher attitudes and behaviors, ... teaching practices, [and] course or curriculum issues.” (p. 568). Even as programming for the first nine interventions may occur at the institutional level, each intervention seeks change at the level of individual students. The tenth *looks* different in that it claims institutional scope, but in reality it addresses teaching attitudes, practice and design, not the structure of the university itself.

I argue that three major problems undermine existing studies’ effectiveness:

- The vast majority of interventions designed to address demographic underrepresentation by gender or race in undergraduate engineering depend on statistical modes for claiming generalization (as defined by Yin¹²). However, the small numbers of white women and people of color in engineering programs mean either that statistical analyses result in non-significant results, or that researchers must aggregate across gender or race in order to make statistically significant conclusions. This project turns instead to research methods specifically designed to examine the experiences of small numbers of people, because small numbers of white women and people of color is what we have.
- Existing interventions assume that the experiences of race and gender are additive rather than interactive. That is, they assume that women of color have the problems of white women simply added to the problems of men of color. Undergraduate diversity programs tend not to differentiate women of color as separate from men of color (when focused on race) or from white women (when focused on gender). Existing research, however, demonstrates that women of color’s experiences of education are different from either of the other two groups, as exemplified by Theodora Regina Berry and Nathalie D.

Mizelle's edited collection¹³ of situated research on and by women of color, Kerry Ann Rockquemore and Tracey Laszloffy's *Black Academic's Guide to Getting Tenure—Without Losing Your Soul*,¹⁴ and research by Maria (Mia) Ong's on "resisting the double bind" (NSF Grants DRL-0635577, DRL-0909762, and 0953861). Little of this has migrated into engineering education research, with two notable exceptions: 1) Cynthia Foor and colleagues' case study of "Inez" articulates the complexity of a multiracial woman's experience in an undergraduate engineering program,¹⁵ and 2) Donna Riley's CAREER-related research using liberative pedagogies to teach thermodynamics makes use of intersectional and critical theories of gender and race.¹⁶ Making use of these works, this project allows for a study of the ways gender and race interact.

- While the number of projects that use qualitative methods to investigate the experiences of underrepresented undergraduate students has increased dramatically, the main focus of these research projects remains on remediation efforts that promote change at the micro level of individual students. However, understanding gender and race involves understanding the construction, maintenance, and resistance of macro social structures, which researchers and scholars still do not understand very well. How individuals interact with these macro structures is via meso institutions: the organizations themselves.¹⁷ To address this problem, this project makes use of sociological research that theorizes institutions as raced and gendered spaces.

Methodology

For those readers unfamiliar with the difference between a methodology and a method, I explain it to my students as follows: a methodology is the theoretical reasoning behind why you think the method – the steps you engage in to collect data and analyze it – will help you answer your research questions. I describe the methodology in this section, and the method in the next.

Intersectional approaches to gender and race

To address the limitations posed by aggregation of data on race and gender in engineering education, this project takes an *intersectional* approach. Intersectionality is a theory first articulated by black feminist scholars such as Kimberlé Crenshaw,¹⁸ bell hooks¹⁹ and Patricia Hill Collins²⁰ that holds as its key contribution the notion that race and gender can not be understood separately from one another, nor separately from other critical social categories such as class, nationality, age, ability, sexuality, and other social dimensions. Indeed, the notion of the "double bind"²¹ or "double jeopardy"¹⁸ experienced by women of color historically implied a pre-intersectionality additive approach, ignoring the oppression women of color experience from the *interaction* of race and gender, and other dimensions. Newer research informed by intersectionality argues the relationship is not additive, but is perhaps complexly multiplicative.

Though limited, there is precedence for this approach in engineering: Cynthia Foor and colleagues' story of Inez, a multi-ethnic woman working to get her undergraduate degree in engineering.¹⁵ The study is student-centric, focused only on Inez, and, making use of critical cultural theory to put Inez's experience into context for majority readers, it does not attempt to claim generalizability. Instead, Foor and her colleagues work to help the reader learn from only

Inez's experience. The power of this single example points to the broad impact this research could achieve by collecting a full range of similarly powerful narratives.

Gender and race as categories of analysis

I will first briefly define gender and race as I use the terms here, and situate them within research investigating organizations and institutions, using key references selected from established social science fields.

“Gender” is the complex categorization system that defines social characteristics as “male” or “female,” by which we organize much of the world.²² Historically these categories have been linked to biological differences between males and females, but social scientists have shown that they are now entirely social, and vary across time and place.²³ Once thought to be biological, race has similarly emerged from a history of complicated social relations organized in and around immigration, nation, labor, class, and gender, with racial groups changing significantly over time.^{24,25} Like people, objects and institutions can also be raced or gendered. Separate public restrooms for women and men are gendered spaces because men and women go to separate restrooms in public, even though they may use the same bathroom in private homes. Churches may be considered raced spaces, as different Christian denominations have very different racial make-ups.

It is important to be clear that describing something as gendered is different from calling it “sexist,” just as describing something as “raced” is not the same as calling it “racist”.^{22,24} Institutions and career patterns have been built around the needs of people of specific genders without intentional sexism. For example, the timing of tenure was set at a time when all professors were men. It thus makes no allowances for the life cycles of people who might plan for pregnancy in their late twenties. This institutional practice was not set *in order to* exclude and thereby discriminate against women (i.e. is not sexist); including women simply never occurred to those developing the tenure process because women were largely absent from the entire professorial equation. The structure of tenure, therefore, is *gendered* because its impact is experienced differently by people of different genders; similarly, something is *raced* when its impact is experienced differently by people of different racial groups, regardless of intent.

In the 1980s and 1990s, feminist sociologists and others exploring these issues started theorizing that women's low participation in positions of institutional, economic, or political power was neither simply an effect of some characteristics of the women's missocialization, nor because of men's sexism. Instead, these scholars argued that the very institutions in which women sought inclusion are instead themselves gendered, raced and classed in ways that promote the success of people participating in an exclusive set of social relations: middle-to-upper classed white men. Joan Acker^{26,27} articulated the existence of a *gendered organization* that facilitated the success of an idealized worker who embodied many of the social privileges of these same middle-to-upper classed white men.

Uncovering the gender and race of policies: Standpoint feminism

Dorothy Smith extended these ideas to call for a sociology that emerged from the lived experiences of people, particularly women, and had as its main driver the understanding of the

ruling relations of constructs and institutions.²⁸⁻³⁰ Specifically, Smith calls for the use of *standpoint feminism*, where one begins inquiry at the locus of a *specific* individual, and explores that person's experiences within a social context in order to uncover what Smith calls "ruling relations".^{28,30,31} Smith defines ruling relations as "that internally coordinated complex of administrative, managerial, professional, and discursive organization that regulates, organizes, governs, and otherwise controls our societies. It is not yet monolithic, but it is pervasive and pervasively interconnected" (p. 49).³² It is these ruling relations that people both experience and reproduce to organize, for example, academic institutions to value certain forms of knowledge and knowing, certain ways of investigating the world, and certain modes of collecting and analyzing data. Smith even writes about the ruling relations in her own academic context:

"This is a world we enter every day when we go to work as sociologists: we enter this world organized in and through texts as we sit down to the computer to write, as we work our way through a stack of papers to grade, as we roam the bookstore looking for ideas for teaching an old course in a new way, as we wrestle with problems of data analysis, as we write a memo to the administration, complaining about the arbitrary and unjust intervention they have made into our affairs. We don't even think of it as a world of relations and ourselves as insiders, as its practitioners. It has an ordinary existence for us, the ordinary existence that the means, objects, and practices our coordinated work creates." (pp. 49-50)³²

Smith argues that policies construct the ruling relations of institutions, thereby constructing the institutions themselves. She argues that mapping the relationships between people's experiences of the policies and the policies themselves will help us understand the social geography of institutions, as well as different institutional aspects of the gendered and raced structure of academic work.

For example, from other parts of my research team's research, we learned from interviews that the main advice women faculty are given regarding the value of service work to their tenure package is that they need to learn to say "no" more often. However, service committees are under institutional edicts to improve representative diversity, prompting them to request women's participation. Women's small numbers on STEM faculties mean that women are asked to participate in service activities more often than their male counterparts, but there is no institutional mechanism to help women manage their commitments—they must simply say "no" more often. Yet we also learn from women's interviews that many want to engage in these service activities in order to "give back" to particularly supportive communities they have had in along their own career paths. And indeed, the service work needs to be done by someone. But as we interrogated a given promotion and tenure policy and interviewed policy administrators, we found that this work is valued poorly within the structure of the dossier and by promotion and tenure committees. So we find an impasse: women are asked more frequently than men to accomplish critical yet poorly valued institutional work. However, rather than develop programs that train women how to say "no" more stridently or more frequently to service requests, my research team and I are more interested in investigating why people—colleagues, administrators, leadership—place so little value on the work that women are disproportionately asked to do on behalf of their students, colleagues, and the institution. This structural quality is a ruling relation: a "way we do things" that has been so normalized that we no longer question its unequal impact.

It is these ruling relations that we must understand if we wish to advance the diversity of engineering as a whole, and undergraduate engineering programs in particular.

Narratives as a research tool

To understand the ruling relations of institutions, Smith argues for using *the lived experience of individuals*.³⁰ That is, we can understand institutions, and thus develop theories about the ways in which they are gendered and raced, only through the lived experiences of individuals within those institutions. Institutions, though they can be mapped systematically, only exert their power through the everyday lives of individuals who operate within them. Thus, in order to address institutional structure, we turn to narrative research methods.

Narrative—the practice and analysis of telling stories, describing shared histories, or constructing testimonials—is a culturally and rhetorically powerful way to communicate deeply the experiences of individuals.^{3,33,34} Narrative has even begun to emerge in engineering education research: at the 2010 American Society for Engineering Education Annual Conference and Exposition, plenary speaker Karan Watson (Interim Provost and Executive Vice President of Texas A&M University) noted the power of using stories to promote cultural and institutional change.³⁵ Indeed, while they are historically rooted in the cultural education of communities, narratives have grown into a broadly accepted qualitative research method that illuminate different aspects of human experience, and have emerged as a way of studying organizations.³³

Although they come from different histories, indigenous, black, Latin@, and multiethnic researchers (along with a few white researchers) have developed a literature of theory and method they propose can reacquire their cultural histories and knowledge. This body of research exists in a sometimes uneasy “coalitional consciousness” (p. 79),³⁶ yet it can teach majority researchers much about the merits of such methodologies. Patricia Hill Collins’ now classic book about black feminist thought²⁰ described to new audiences the contributions of black feminist scholars and activists. Linda Tuhiwai Smith³⁷ has written extensively on decolonizing methodologies, which hail from indigenous scholars and activists developing strategies to resist white researchers’ appropriation of their cultural lands and knowledge. Others have made use of Brazilian educator and literacy activist Paulo Freire’s now famous concept of “pedagogies of the oppressed”³⁸ where people under different forms of oppression are taught basic skills using the concepts that have forced them into oppression; still others acknowledge Chela Sandoval’s phrase “methodologies of the oppressed” to talk about different ways of doing analysis.³⁶

The use of narrative and storytelling has become acknowledged as hybridizing a cultural activity with a research method, serving as one among many decolonizing methods that have a history of use in indigenous communities and communities of color^{37,39} (as indeed in white communities). Researchers in the social sciences have been using narrative to understand complexity within individuals’ experience.³³ Cynthia Winston and colleagues⁴⁰ use narrative via the telling of “life stories” to create cases of black students in STEM disciplines both as a way to think about their personal psychological development and for students to learn about themselves. Cultural performers including Anna Deavere Smith,^{41,42} the national storytelling project *StoryCorps* broadcast on National Public Radio and archived in the Library of Congress (storycorps.org), and the hosts and producers of the radio and television shows *This American Life* (thisamericanlife.org, produced by WBEZ-Chicago), among many others, have performed

narrative (via documentary theater or simply good radio) to create powerful social commentary on the everyday lives of often overlooked and marginalized people. More relevant yet is dramatic narrative used in science education: Marianne Ødegaard⁴³ summarizes different cases where science and scientific understanding has been explored through different forms of drama and performance.

Using storytelling or other cultural practices as a research method is argued to have the capacity to serve as a decolonizing practice, but also has critiques by indigenous researchers and others. To mediate against these methods simply acting as an additional means to reinforce power relations between majority and minority cultures, Tuhiwai Smith articulates specific questions that researchers wanting to work with indigenous communities must answer early in the research relationship; we have answered these questions, and published the responses on the project's website (http://feministengineering.org/?page_id=577). But Tuhiwai Smith also advocates for the telling of stories, in particular the practice of “claiming,” and telling testimonials as “a means through which oral evidence is presented to a particular type of audience” (p. 144).³⁷ citing Russell Bishop's⁴⁴ argument that “story telling is a useful and culturally appropriate way of representing the ‘diversities of truth’ within which the story teller rather than the researcher retains control.” (p. 145) Thus the methodology we employ in this project, when used ethically, holds substantial power to help illuminate the experience of race and gender in engineering education.

Problems with using narratives

However, there is a problematic aspect to white researchers (as I am and as a number – although not all – of my research team are) studying people of color and their stories. Some key problems might be summarized as: appropriation and often theft of cultural artifacts and knowledge by non-Native or white researchers; the application of research methods disrespectful of cultural groups, practices, or ways of knowing; and the absence of appropriate impact or relevance returned to the community. While as a white researcher I must work diligently to become and remain aware of how white privilege impacts my worldview and research, I can contribute to countering these “colonizing methodologies” by deliberately making use of decolonizing theories and methods to help educate other similarly privileged people in doing emancipatory research. This practice is a life's work. In this research I deliberately make use of critical decolonizing theories and methods to help privileged engineering education leadership understand the institutional experience of undergraduates of color at primarily white institutions, and I strive to partner with people of color as a constant connection with the communities who participate in the research.

In addition, the participation in storytelling acts guided by decolonizing research philosophies brings with it responsibility.^{37,45} In his book, *The Truth About Stories: A Native Narrative*,³⁴ Thomas King opens each of his chapters with a traditional story, and closes each with this reminder: “Take [this same] story, for instance. It's yours. Do with it what you will. Tell it to friends. Turn it into a television movie. Forget it. But don't say in the years to come that you would have lived your life differently if only you had heard this story. You've heard it now.” To acknowledge peoples' sharing of their stories, I share this insight with readers of this research and will incorporate it into the study's resulting dissemination products.

Methods

In this section, I describe in detail the methods my team and I are currently using to recruit participants, interview them in order to collect data to answer our research questions, process and clean it, and our current work on analysis. However, as I have already introduced, we are striving to develop an analytic process that both respects the story and storyteller and allows us to learn from their stories about educational institutions.

Table 2 introduces the participants to whom I have listened so far.

Name/pseudonym	Gender	Race/ethnicity (Self-reported categories)	School	Age
Andrew	Male	Black, African American	Howard University	21
Chelsea	Female	African American	North Carolina State	21
Jasmine	Female	Non-Latino, Black/African American, American Citizen	Morgan State	19
Mayen	Female	Black	Penn State	22
Moises	Male	African American Hatian American	Virginia Tech	22
Nathan	Male	African American	University of Pittsburgh	22
Sammie	Male	Black or African American	University of Alaska-Fairbanks	25
Tristin	Female	Diné	Columbia University	21
Tyson	Male	Black	Howard University	20
Vera	Female		University of Texas-Austin	
Xuan	Female	Vietnamese (mixed race)	DeVry University	35

Recruitment

I have progressed through multiple methods of recruitment since the start of this project. The original plan had been to have a two-phase recruitment process: first, I would partner with “professional engineering diversity organizations” – the Society of Women Engineers, the National Society for Black Engineers, the American Indian Science and Engineering Society, and the Society of Hispanic Professional Engineers – to recruit undergraduate engineering participants at their national meetings and conduct the interviews on site. Eligibility requirements are that the student be an engineering undergrad or recent graduate (within the last 6 months or so), and identify as African American or Black, Native American, Latin@/Chican@ or as multiethnic, or as a white woman, and have an interesting story to tell (as determined by them).

However, students who have the financial resources to attend the national conference of these organizations may also form a particular cohort of students who have different social and cultural capital from their colleagues who were unable to come. Put another way, these conference attendees may experience their educational institutions in qualitatively different ways than their peers who did not attend the conference. As a result, I planned to do a second phase of interviewing with undergraduates at four additional institutions selected to have a higher representation of women or students of color as engineering undergraduates than the national average or who have a higher number of women or people of color participants overall (in that the institution may be designed differently). Sites were to be selected to fill institutional and

conceptual holes left from the institutional coverage of the first round of interviewing (such as soliciting participation from tribal colleges or women's colleges which may or may not have engineering programs).

However, applying the strategy of the first recruitment phase at two conferences led to only modest success. I had far fewer interviews than I had anticipated collecting per conference, while the cost of attending (travel, hotel, registration, and fee paid to the host organization to cover expenses associated with using a room for interviewing) were considerable. Recruiting through social media ahead of the conference with the organizations' help yielded almost no participants signed up in advance. Once on site, it proved difficult to convince undergraduate participants to leave the other exciting offerings of the conference to come talk with me for a long period of time, even though I offered \$30 as an incentive in recognition for their time. In addition, there were many instances of miscommunication exacerbated by poor cell phone signals, no Wi-Fi, confusing remote and isolated interview room locations, and a misunderstanding about the type of research I was conducting (interviews rather than surveys).

After some consulting with my advisory circle members and my research team, I decided to shift my recruitment strategy. I would still try to recruit people from conferences, but not try to interview them on site, but instead interview them remotely via phone, Skype, Google+, FaceTime, or other video chat platforms. In addition, I implemented a snowball strategy,³ asking participants who else they knew who had interesting stories of their undergrad that they thought I should interview, and to please spread the word. Through this method removing the requirement to travel, I have increased my potential for reaching students at diverse institutions by removing the requirement to travel.

Data collection

In addition to face-to-face interviews conducted at two conferences, I have now also successfully conducted interviews by Skype, phone, and FaceTime; nuances about doing interviews remotely include emailing the consent form in advance, discussing particular aspects before doing the interview, asking for verbal consent before doing the interview, then requesting participants scan and email, fax, mail, or photograph and email the signed consent form.

For face-to-face interviews, I compensated participants with \$30 cash after they complete the interview and financial paperwork. For remote interviews, I compensate participants with a \$30 gift card to Amazon.com upon receipt of the consent form, rather than with cash that would require they complete and return additional physical paperwork.

In this research, we do not presume that participants' names and details should be pseudonymized to protect their identities. As participants are invited to share their personal stories with us, to presume that their names and personal details should be stripped from their stories we felt would be disrespectful and presumptuous. Instead, we invite participants to tell us (after the interview is completed so they know what they have said) whether they want their story to be pseudonymized, or whether we should keep their first name attached to it and other details (names of schools, locations, and so forth). If they want it pseudonymized, then we invite them to choose their own pseudonym. This allows the participant to identify himself or herself in

published papers, gives her or him some control over her or his own story, and allows us to avoid any bias in assigning ethnically or otherwise (unintentionally) inappropriate pseudonyms.

For this study the interview protocol consisted of an initial set question to allow participants to tell their stories in whatever way they chose. This decision had its roots in feminist critiques of the power relationship between researcher and participant – the participant shares potentially intimate details of his or her life with a stranger, the researcher, who does not reciprocate in this sharing. So instead, with this open protocol, participants have more control over where they begin, the language flavor they use, and the narrative arc important to them.³⁷

However, after doing a series of interviews, I realized that some participants were looking for more structure, so I developed a variety of prompts to use as indicated as needed by the participant. The complete protocol is included in Table 3.

Table 3: Interview protocol: questions only.	
1.	How did you get to be where you are?
2.	Prompts as needed:
a.	Tell me a little about yourself.
b.	Tell me a bit about your family.
c.	Tell me about where you're going to college. Tell me how you got there.
d.	What about the structure of college helped or made things difficult?
e.	What about [SWE, NSBE, AISES, SHPE] helps or makes things difficult?
f.	What are your plans for the future?
g.	Anything else you'd like to tell me?
3.	Probes on institutional structures – financial, early education, later education, city/community services, religious institutions, student support, transportation, rules and regulations inside the university/college like transfer rules, admission rules, graduation rules...
4.	Generic prompts:
a.	Let's talk about that for a minute.
b.	Tell me more about that.
c.	So, just to clarify...
d.	How did you learn this?
e.	What about this was important to you?
f.	Any regrets? Anything you wish had been different?

Shortly after each interview (within the next day), I completed a modified memo based on Miles and Huberman's contact summary form to capture immediate reflections on the interview and to prepare for the next interview. These reflection questions are reproduced in Table 4.

Table 4: Post-interview reflection (memo). From Miles & Huberman's ⁴⁶ contact summary form (p. 53)	
1.	What were the main issues that struck you in this interview?
2.	Summarize the information you got (or failed to get) on each of the target interview areas you had.
3.	Anything else that struck you as salient, interesting, illuminating or important in this interview? Any patterns?
4.	What new (or remaining) questions do you have in considering next interview with another subject?

Data cleaning

We have the interview recordings transcribed by a professional transcriber who has signed a confidentiality statement provided by our IRB office. We review the transcript and the recording together for typos in the transcript and words that the transcriber misheard or misunderstood. If the participant has asked to be pseudonymized, we mask names, places, ages, organizations, school details (including department, college, and university names and locations), disciplines, ethnic groups (replacing them with broader racial categories), nationalities, languages, and religious affiliations or communities. Irrespective of the participant's pseudonymization choice, we mask the names of other people he or she mentions, as they have not given consent for our use of their names and stories.

Analysis

Analysis is done on corrected but unpseudonymized transcripts. Text that is used in publications is from pseudonymized transcripts as designated by the participant.

We had planned to do two stages of analysis in series. We intended to begin analysis with a deductive coding pass structured by Smith's theories of the ruling relations: we would look for times when the participants interact with the institutional structure via policies, including the funding of their education, their admission to the institution, how they decided on their courses, what impact their being at school has meant for their families, and so on. This deductive coding was to be supplemented with an analysis of the texts themselves referred to within the interviews; publicly available policy texts will be accessed via institutions' websites, or through a direct request the appropriate institutional administrative staff. Once we completed a deductive coding of each interview, we were going to engage in inductive coding based on key ideas expressed in the interview that were not captured through the deductive coding. Upon completion of both coding phases (which would have actually involved multiple passes over the textual data), we would construct various data concentration/display matrices as guided by Miles and Huberman⁴⁶ to help develop answers to our research questions. The team has experience with this kind of analysis across multiple projects.

It was not so easy to put this plan into practice, however. To code in the way we had anticipated, we needed to decide how to operationalize the theoretical framework: what would "ruling relations" look like in the context of these stories? We had thought that conducting structural coding⁴⁷ – where structural codes help index transcripts to make specific chunks quickly locatable for a larger analysis – would be useful: we would label participants' interactions with different institutions, like financial systems, transportation systems, rules in the university. Alongside this, we considered applying provisional coding,⁴⁷ where our theoretical framework of the ruling relations would supply initial provisional codes for our deductive pass. We also thought that, considering the dramatic storytelling component, that dramaturgical coding⁴⁷ may be useful, where terms associated with dramatic performance are metaphorically mapped onto the story.

My team and I started to code multiple sections of different interviews, particularly focusing on these types of institutions that participants mentioned explicitly, to try to gain insight to their

experiences. But two things resulted from this: first, because we gave participants the freedom to tell their stories however they wanted, we found the institutional interactions were very dispersed over the interview, and extraordinarily contextually based; and second, when they were coded, the stories fell apart – the stories were larger than the sum of the codes we applied to them. We are beginning to feel as though codes function too much to break down stories into component parts, but the parts *together* are perhaps more important.

In some sense, in doing this research I feel confronted by a sense of “tyranny of the method.” Quantitative methods are relatively well understood and regularly applied and reviewed in engineering education conferences and publications. Qualitative methods are increasingly being incorporated into both disciplinary conferences and journals, but tend to use interview-based data that are thematically analyzed, and reviewers are becoming more skilled at reviewing such work. But my team and I are discovering that “learning from small numbers” may require us to develop new (to engineering education) methods that ask us to look at data differently, and which will require reviewers to be able to judge them although they do not conform to the discipline’s methodological habits.

Saldaña⁴⁷ describes codes as “a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data.” (p. 3) The “portion” of data is a segmented chunk of an interview transcript, video, set of field notes, or any other type of captured information, and how the chunk is segmented depends on the methodological viewpoint of the researcher and on the research question at hand. Segments can be words or phrases, complete sentences, paragraphs (inferred through context), or even longer chunks of text. Saldaña provides an excellent in-depth treatment of the practice and process of coding and memoing, as well as a helpful framework describing first pass coding and second pass coding.

It is important to note, however, that this style of coding tries to condense one’s thinking about a particular datum to a representative or summative phrase. Most often, we use codes to summarize these thoughts across data sources; that is, we develop code structures to apply across multiple transcripts, and then use those code structures to develop some kind of theory with respect to our research questions. The strength of this form of coding is to give comparison across a large number (comparatively speaking) of subjects.

But as I have already described, in the data we are collecting for this research we are finding it difficult to capture the essence of each story through applying the same set of codes across our transcripts. Philosophically, we are trying to learn from the details each instance, not just what those instances have in common or in contrast with each other across a defined set of dimensions.

As a result, we are beginning to explore other coding practices, as well as other methodological traditions that use more case-oriented tools to help us learn about the “general” (educational institutional structure) from the specific (students’ stories). In particular, we are exploring “in-vivo” coding,⁴⁷ a form of coding that uses participants’ own phrase to summarize a particular chunk of text, thereby creating unique labels specific to a participant. Choosing to in-vivo code will require how we use our qualitative data analysis software (QDAS; we are using Dedoose,

dedoose.com) to change, as loading transcripts into one project forces the use of a common set of codes. We will also develop a practice of making marginal remarks. Miles and Huberman⁴⁶ describe marginal remarks as a form of preanalytic memoing, but we believe it will help us in the later analysis to be able to see them together in the margin of the transcript rather than separated from each other as structured by the QDAS). This marginal remarking can be conducted by multiple researchers to “suggest new interpretations, leads, connections with other parts of the data, and they usually point toward questions and issues to look into during the next wave of data collection, and to ways of elaborating some of these ideas.” (p. 67)⁴⁶

Once this first pass of coding is completed on our existing set of transcripts, we must consider ways to combine what we have learned from each transcript (in the form of in-vivo codes and marginal notes) with our memos from the interview summary forms. Saldaña calls this second pass “second cycle coding methods”.⁴⁷ Miles and Huberman advocate the construction of data displays for this secondary analysis.⁴⁶ I currently think we will need to cluster the in-vivo codes and other data together to see whether they connect to any particular practices we can identify as ruling relations; perhaps using the *micro*, *meso*, and *macro* framework described earlier can help us structure these.

This alternative analysis scheme is still based on codes, but applied and used in ways that are less common in engineering education research. We are considering two other methodological traditions that dispense with the application of codes: microhistory and testimony. Microhistory is a practice used by historians to tell a detailed history about a particularly local or specific site, person, situation in order to understand the history of the larger society; a classic example is Carlo Ginzburg’s microhistory⁴⁸ of Menocchio, an Italian village miller in the 16th century who was interrogated by the Inquisition about his heretical ideas. Through Menocchio’s story, which only came to life through the records kept by the Inquisition, Ginzburg tells the reader about life and culture in the 16th century. Testimony, by contrast, prompts us to think about case law, where through one very specific case, general law is interpreted and applied; however, it also has a connection with the decolonizing methods that Tuhiwai Smith describes.³⁷ Analogously to both of these alternatives who use deep focus on small numbers of subjects to understand bigger projects, our participants serve as the focus of the research, but the subject of the research is the structure of ruling relations and institutions, accessed via participants’ stories.

Future work

While we have just described various analytical strategies to concentrate, aggregate, and communicate information about institutions from narratives, we also need other methods that preserve the narrative “voice” of participants in dissemination products, as emphasized by Watson³⁵ and Tuhiwai Smith³⁷, to communicate findings to engineering educational leadership. We anticipate needing to transform transcripts into condensed narratives.

Design researchers working at design firms such as IDEO, Cheskin, or Interval Research have developed an innovative method that can facilitate this transformation: the creation of *personas*, or short profiles of fictionalized individuals who may represent aggregated data about design populations in a narrative and specific way.^{49–51} While personas will be constructed from the narratives to be used as tools within the educational component of this project, narratives

themselves also serve as research finding delivery modes. In this research, narratives are constructed from edited adaptations of the interview transcripts. Participants are invited to comment on transcripts and narratives as a matter of course, and on personas as appropriate, and revised to best incorporate their concerns. The narratives will supplement the findings from the interviews, help develop the personas, and serve as the content around which additional non-research oriented publications will be explored in partnership with participant individuals and site organizations.

By leveraging this approach to design, the narratives collected through the research component will be processed into these individual or composite personas, which often include a name, representative image or photograph, demographic characteristics, behavioral characteristics, barriers or challenges, and specific goals or needs.⁵² In addition, while reading the personas may be themselves critical learning experiences, design researchers have also developed methods by which they embody (even bodily) the daily experiences of their design population who are often socially, economically, or demographically far removed from the designers themselves. Brenda Laurel, Eric Dishman, and Bonnie Johnson have introduced *informance*—a concept that combines the words "information" and "performance" —as one of these learning tools.^{53–55}

Conclusion

So far in this research I have strived to weave my commitment to honoring participants' stories through the theoretical underpinnings, data collection and cleaning methods and analysis, which has yielded some challenges in aligning with commonly recognized methods in engineering education research. I find that the participants' narratives have an integrity of their own; even though they are not necessarily carefully shaped stories that flow without interruption as would a novel, they are an integral whole, and it seems problematic to take them apart. As a result, I have used this paper as a forum to explore some alternative analysis methods to coding and thematic analysis, including being inspired by other disciplines' traditions, with the intent to provoke discussion around the notion of analyzing small numbers of stories – as those are what we have when we consider white women and students of color in engineering undergraduate programs.

And so, in the spirit of strong objectivity and building trustworthiness in qualitative analysis, I ask the reader: does this seem a plausible path forward? What other ways do you have that may be fruitful for us to consider when approaching these data? And how might we as a community of researchers develop expertise with methods that can help us better learn from small numbers?

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