THE ROLE OF MOTIVATION AND IDENTITY IN HISTORICALLY BLACK COLLEGE AND UNIVERSITY STUDENTS' PURSUIT OF COMPUTER SCIENCE AND ELECTRICAL ENGINEERING

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I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

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Introduction

This is an exploration of the experience of underrepresented minority (URM) university students on the STEM pathway, and the challenges that they face in introductory, gatekeeper classes and advanced electives. I set out to generate "research that advances knowledge about fundamental principles of early-stage testing of innovative programs, policies and practices to improve education outcomes" (NSF, 2013, p.12). While there has been a great deal of exploration into the shortage of URMs in STEM careers, very few researchers have focused on what it is like for a student to experience the challenges of a gatekeeper course, and perform poorly and/or fail. As an example of one STEM pathway track, Don Barr and John Matsui at Stanford and Berkeley respectively have noted pain points within the pre-med process and talked about the specific point along the pathway where many Latino students decided to abandon their original education and career track goals. Beyond their work, very little research has been carried out to flesh out the experience and the possible instructional and institutional design failures leading to URM attrition. Most often the onus for this dropout rate falls on the students themselves.

Rhetoric rife with deficit-laden terms such as 'disadvantaged backgrounds', 'under-resourced high schools', and ‘underprepared students' has created a blind-spot in this area of study, and research has done little to document the nuances of what it’s actually like to fail in these courses and to give up on major career aspirations. The problem with the use of this student deficit rhetoric is the assumption that something must be done to make these students better performers with greater preparation at the K-12 level, so that they can succeed at what is considered a fair and just level of difficulty at the level of higher learning. It enables those in higher education to abandon the idea that the programs in

which students are learning are flawed, and that the answer might lie in innovating pedagogy at the college level. At the terminal end of the pipeline large technology companies, Research-1 universities and professional education programs face dwindling numbers of URM matriculants and employees. Many of these institutions respond by deflecting the diversity problems they currently face by claiming that the solution can only be found upstream in the K-12 setting.

The NSF's Common Guidelines for Education Research and Development state that "the purpose of Foundational Research is to advance the frontiers of Foundational, Early-Stage or Exploratory, and Design and Development Studies" (NSF, 2013, p.12). Thus far, the Academy has not officially recognized the learning experience of URM students in college STEM courses as one that is challenged by the design and execution of the educational institutions themselves. Failure and attrition is instead explained away by characterizing the students' poor performance, poor preparation and intellectual shortcomings. Calls to improve student preparation prior to university matriculation are well founded, but at the same time there are thousands of URM students capable enough to have already won a place in higher education, that are also facing poor pedagogical practices and antiquated curricular design, which may play a large role in their decisions to abandon their ultimate dream careers. More research must be done now to help URM students achieve their goals in the STEM fields. Educational researchers and university administrators need to take it upon themselves to characterize these students' challenges so that changes can be made to the design of STEM learning that will be inclusive of people from underrepresented backgrounds. My study contributes to advancing the "foundational knowledge that guides theory development; Early-Stage or Exploratory research to identify evidence of the promise (or lack thereof) of programs, policies or practices; and research that guides the development and early-stage testing of innovative programs, policies and practices to improve education outcomes" (NSF, 2013, p.12). This

work is an early step toward shedding light on the challenges URM students are facing, and I hope to generate an ongoing career-long arc of research that contributes to examining these phenomena to establish explicit links between the student experience and educational outcomes. My true intent is to establish a "basis for (the) design and development of new interventions or strategies" (NSF, 2013, p.12). Ultimately, I hope this work can establish a basis for the development of new institutional strategies around designing curriculum to be more inclusive and equitable.

Multiple analysts predict that the American workforce needs approximately 1 million more STEM workers than the United States is currently capable of training in order to remain a global economic competitor (President's Council of Advisors on Science and Technology, 2012, Lacey, 2009, Langdon, 2011). This projected shortage in a future skilled workforce has led to a narrowing of education rhetoric to the point where education is viewed primarily as training to prepare citizens for STEM jobs. A prime example of this employment-focused shift in rhetoric is seen in the U.S. Department of Education's launch of the online platform 'College Scorecard'. College Scorecard is an attempt to make the investment in college more transparent to the U.S. consumer. While definitely useful for families exploring the cost of their child's education, a program like this also characterizes education as both a necessity for individual economic opportunity, and for global economic competitiveness. In other words, one's education is a commodity. Importantly, people of color and first-generation college students have traditionally been underrepresented in the STEM fields, and this underrepresentation plays a critical role in addressing the STEM crisis for the nation. The Department of Health & Human Services, the National Science Foundation, and the National Institutes of Health (2012), all believe in involving underrepresented minority students in the ramping up of STEM education in order to address this future projected job shortages. In 2012, for example, The Executive Office of the President, President's Council of

Advisors on Science and Technology described Underrepresented Minority (URM) students as an underutilized source of potential STEM professionals deserving special attention in training (President's Council of Advisors on Science and Technology, 2012). There is clearly an increased interest in involving URM students in the STEM fields, but I think there are better justifications for this involvement than our country's global economic competitiveness.

Griffith, et al. (2010) carried out a regression analysis using data from the National Longitudinal Survey of Freshmen (NLSF) and the National Education Longitudinal Study of 1988 (NELS: 1988) to examine which factors contribute to the academic persistence of women and minorities in STEM field majors. They found that differences in preparation and prior educational experience explained much of the difference in persistence rates when women and URMs were compared to male and non-minority students. They also found that at selective institutions with higher graduate to undergraduate student ratios, as well as institutions that invest in higher amounts of spending on research, the institutions end up with URM and female students with lower persistence rates in the STEM fields (Griffith, 2010). It is common for students to enter college focusing on one area of study or major, to then change that major focus sometime near their junior year. This change is more common among students whose intended major is in the STEM fields, and even more common among URM students, than among non-minority students (Griffiths, 2010, National Science Board, 2007). Moreover, URMs leave STEM majors at higher rates than non-URM groups, which contributes to a substantially lower number of URMs completing their college degrees within these major fields (Griffith, 2010). Of equal importance is the forecasting of a substantial change in the demographic makeup of the United States over the next two decades, further supporting the characterization of URMs as a pool of untapped talent. (President's Council of Advisors on Science and Technology, 2012, Jackson, 2004, Griffith, 2010)

In their seminal work *Talking About Leaving – Why Undergraduates Leave the Sciences*, Seymour & Hewitt (1997) conducted a three-year, seven-campus study in which they carried out 600 hours of ethnographic interviews and focus groups to find that disproportionately greater numbers of the most highly-qualified women and URM students were lost from the STEM pathway (Seymour & Hewitt, 1997). The researchers found that faculty members at these and similar institutions traditionally saw this fall off in student persistence as beneficial and largely needed to weed out those least qualified, and select those best qualified for STEM careers, citing students' "wrong choices, under-preparation, lack of sufficient interest, ability or hard work, or … the discovery of a passion for another discipline" (Seymour et al., 1997, p. 391-2). Yet the researchers found little data to support this argument when they spoke with the students themselves. Instead they found in all the groups they sampled, discouragement from poor teaching structures, the weed-out mentality baked into the school's culture, and a level of indifference, which students regularly faced from their professors (Seymour & Hewitt, 1997). A great deal more work needs to be done to characterize the pre-STEM experience for students at U.S. colleges, but as a starting point a small number of researchers have shown that URMs in the premedical pipeline exit this pathway at a high rate often due to inadequate science preparation, and ultimately poor grades in premedical courses, and this often happens during the students' freshmen and sophomore years (Gonzalez, 2010; Thurmond & Cregler, 1999). Recent research has found that a principal reason for this URM attrition from the premedical pipeline is a loss in interest, specifically after taking courses in Chemistry (Gonzalez, 2010; Barr, Gonzalez, & Wanat, 2008).

The Medical Field Argument for Diversity

The National Science Foundation (NSF) and the National Institutes of Health (NIH) have channeled funding into increasing the number African Americans, Latinos, Native Americans, and mainland Puerto Ricans, groups traditionally considered to be Underrepresented Minority students in the STEM fields, as these groups lag White and Asian American student populations (Hurtado, 2010, NSF, 2007, Gonzalez, 2010, U.S. Department of Health and Human Services Health Resources and Services Administration, 2006). Some of this investment is focused on healthcare in hopes of diversifying the workforce driving both the basic sciences as well as more applied science fields like clinical research, as these URM groups are also significantly underrepresented in the health professions (Gonzalez, 2010, Hurtado, 2010, National Academy of Sciences, 2007, U.S. Department of Health and Human Services Health Resources and Services Administration, 2006, Smedley, 2003).

A clear need for diversity in this specific arm of STEM (Healthcare & Biomedical Sciences) means a need for a culturally competent healthcare workforce. While an equity argument can be made for the need for a more diverse population in these fields, the knowledge base in the basic sciences and the applied research fields is also very important for the health and well-being of an already diverse society. The need for scientists and clinicians from different cultural backgrounds to create cures and carry out treatment for that diverse population is very clear. URMs that study to become clinicians share some of the ethnic, cultural, and socioeconomic status (SES) experiences that many of their patients have also have. The need to diversify the researcher and clinician pool is really a need for a better understanding of, empathizing with, and caring for, patients from diverse backgrounds. As the number of URMs applying to and graduating from medical schools in the U.S. has declined, researchers have focused specifically on the premedical pipeline that funnels URM students into medical schools (Gonzalez 2010, AAMC, 2005, Anderson, 2003, Cohen & Steinecke, 2006; Thomson & Denk, 1999).

Exploring the Engineering Field's Need for Diversity

During the Fall, Winter, and Spring quarters of the 16'-17' academic school year I was given the opportunity to carry out a Course Assistantship for Professor Sheri Sheppard's course Engineering 311C, Expanding Engineering Limits: Culture, Diversity, and Gender. The course focused on the ways in which culture, diversity, and gender shape whom is given the opportunity to become an engineer, and based on the answers to those questions, what problems get prioritized, worked on, and ultimately solved. In exploring how gender and diversity are experienced in engineering cultures, and what consequences a homogenous culture create for innovation within the engineering profession, I found starkly clear examples of the argument for diversity in these areas of STEM as well, with specific examples in engineering. For example, Kodak, a company that dominated the photography industry for an entire generation, set its portraiture lighting standards specifically on Caucasian subjects' skin tones. As Kodak designed the standards for modern day photographic technology in the western world, it's possible that many of our current forms of photography, film, and video are not set to accurately pick up the details of varied skin tones. We see another example in the automobile industry. Since the inception of the industry's safety standards, automobiles have been manufactured with seat belts designed with the help of safety data generated solely from the experience of male anatomy and physiology in crash testing. Modern day seatbelts therefore are not actually rated as safe for women, and especially not safe for women that are pregnant.

By assisting in the design of the class Fall quarter, its execution Winter quarter, and a follow up qualitative study on the experience of its students Spring quarter, I generated a number of literature references and in-person accounts of the paucity of underrepresented

minorities and women in Engineering in both Higher Learning and industry environments. After completing my work for the course, Professor Sheppard offered me to opportunity to analyze data that the Center for the Advancement of Engineering Education has generated on the experience of engineering students across a wide array of college campuses in a study called the Academic Pathways Study (APS), specifically data from the Academic Pathways of People Learning Engineering Survey (APPLES). In my work I focus specifically on URM Computer Science, Computer Engineering, and Electrical Engineering students, so that I might take advantage of this data-opportunity, structure my dissertation work on a field that is clearly facing diversity challenges, and complete much needed research for Stanford's Designing Education Lab (DEL) as well.

Research Questions

APS is a longitudinal, cross-sectional study of undergraduate engineering students' educational experience, including their transition to the workforce. 4,200 engineering undergraduates at 21 U.S. campuses were sampled and the study generated data through a series of qualitative studies that included semi-structured interviews and surveys ("Academic Pathways Survey," n.d., para. 1). A portion of the interviews and open-ended survey questions have yet to be analyzed. The APS work is categorized into four sections of study: skills, identity, education, and workplace. While my analysis may venture into both the skills and workplace sections of the study, the major focus of my analysis will be targeted at the *identity* and *education* segments. The study's *identity* focused research questions are: "How does one's identity as an engineer evolve? How does student appreciation, confidence, and commitment for engineering change during the undergraduate educational experience? How do these changes impact student decisions about pursuing engineering after graduation?" The study's *education* focused research

questions are: “What elements of students’ engineering educations contribute to changes observed in their skills and identity? What do students find difficult and how do they deal with the difficulties they face?” As I searched available data, my analysis began with a focus on my original research questions below. I’ve listed three large question areas, and used my final data set to provide insight and answers to these questions.

How do URM students think about and attach meaning to their experiences in introductory STEM courses?

1. What is the experience of URM students in introductory Computer Science and Engineering courses?
2. How do these students conceptualize their performance in these courses and what role does that performance play in their perception of themselves as future engineers?
3. Do these students identify as underrepresented minorities, and how does this identification or non-identification play into their experience in these courses and on the pathway to STEM careers?

How does their perception of tangible learning experiences play into their persistence in their major?

1. Within the context of the courses, where are these students finding success in performance and learning, and where are they finding themselves most challenged?
2. What specific content in these courses proves easy for them to learn, and what content is the most challenging?
3. When it comes to lecture, lab, problem sets, discussion sections, reviews, and study strategies, what is helping students perform well or hindering their performance, and what is helping them internalize content for the long term or hindering their long-term learning?

What do students suggest would make the situation better for them and others?

1. If these courses were to be redesigned to help them succeed, how would that look, what would they suggest changing?

2. What resources outside of those provided by the course itself are these students relying on to complete their courses?

3. What are their future plans and strategies for dealing with additional classes that are required of their major or their career goals, and how do they expect they will fare?

4. What is their perception of students that stay in the pipeline to reach their ultimate goal vs. their perception of students that step off of the path, and how do they perceive their own identity as it might fit into either of these outcomes?

Methods & Analysis

Herein is an analysis of the experience of URM engineering students studying Computer Science, Computer Engineering, and Electrical Engineering. I analyze data from in-depth interviews and surveys focused on students' preparation and performance in gatekeeper courses which focused on study-planning, reflection on degree and career goals, and feelings around identity and preparedness when it came to their performance in these classes, as well as their feelings around entering, continuing in, and/or leaving the STEM major/career pathway. As there is vast evidence to show that experiences in these classes bear on students' decisions to continue on or step off of the path, my search will be focused on finding the student interpretation of the specific characteristics of the courses, institutional culture (i.e. suggestions from academic deans, pre-major advisors, members of the teaching team), and student body culture (i.e., what students perceive is expected

of them in terms of class enrollment and performance, and what is reinforced by fellow classmates at their university when taking classes on this path).

Very similar to Barr et al.'s (2009) study, I target URM (in this case engineering) students at one university. While all the schools sampled are selective, the school that I target, UPri an Historically Black College & University (HBCU), unlike the other schools, also serves a primarily URM population. Due to it's URM focus, this study may be able to further shed light on the different experiences of URM students at an array of universities. One reason for using a sample from an HBCU is convenience, as minority serving institutions (MSIs) clearly have a larger prevalence of URM students. However, beyond my wish to sample for convenience, it was also my early hypothesis that the experiences of URM students at an institution in which they are the majority, might limit some of the negative influences of institutionalized racism and discrimination present in the infrastructure of the U.S. educational system. I soon found that even within the Black diaspora that makes up HBCUs, there are different levels of privilege and cultural identity that can impact the student experience. I do continue however, to believe that beginning with a minority serving institution is a sound strategic step in exploring this area of research. Getting more granularity on what the URM experience is like in engineering at an institution that was originally designed to serve URMs is a very useful place to begin, with further study to branch off to different types of universities from there. I would hypothesize that an MSI like UPri has since its founding, tried to take into account the unique needs of URM students in a country that was in fact founded on slavery and genocide. Understanding the needs, successes, and failures of the students that MSIs were built for, will hopefully give us a baseline reading of what a successful pedagogical and curricular design might actually look like for these students. The data from APPLES is similar in structure to Barr et al. (2009), as each study has mixed semi-structured interviewing, coupled with survey to glean deeper insights into the data that

each complementary method generated. Additionally, Lin et al.'s (2013) critical review of current research on premedical students noted that defining the premedical population to sample, in itself can be a challenge because any course work or activities carried out before medical school by students that either eventually matriculate to medical school or do not matriculate, can be called premedical. I searched for and found unique but similar challenges in trying to define early engineering students here as well. While this group might be more clearly defined by major, that major holds a great deal of variation in student concentrations and future career goals especially. I carried out a qualitative, discourse analysis on student responses to questions about their experience in these intro-STEM courses. Applying grounded theory (Glaser & Strauss, 1967), and using a case study approach I conducted an open coding process with my data sets (semi structured ethnographic interviews for six students). I ultimately iterated on the structure of my coding scheme to include values centered around both identity and motivation, as I looked for themes that represented the URM student experience.

Literature Review

Underrepresented Minorities and the STEM Pipeline

Multiple analysts predict that the American workforce needs approximately 1 million more Science, Technology, Engineering & Math (STEM) workers than the United States appears currently capable of training, in order to remain a global economic competitor (President's Council of Advisors on Science and Technology, 2012, Lacey, 2009, Langdon, 2011). This projected shortage in a future skilled workforce has led to a narrowing of education rhetoric to the point that education is viewed primarily as training, which prepares citizens for STEM jobs. A prime example of this employment-

focused shift in educational rhetoric is seen in the U.S. Department of Education's launch of the online platform 'College Scorecard'. College Scorecard is an attempt to make the investment in college more transparent to the U.S. consumer. While definitely useful for families exploring the cost of their child's education, a program like this also characterizes education as both a necessity for individual economic opportunity, and for global economic competitiveness. In other words, one's education is a commodity. Importantly, people of color and first generation college students have traditionally been underrepresented in the STEM fields, and this underrepresentation plays a critical role in addressing the STEM crisis for the nation. Health & Human Services, the National Science Foundation, and the National Institutes of Health (2012), all believe in involving underrepresented minority students in the ramping up of STEM education in order to address this future proposed job shortage. In 2012, for example, The Executive Office of the President, President's Council of Advisors on Science and Technology described Underrepresented Minority (URM) students as an underutilized source of potential STEM professionals deserving special attention in training (President's Council of Advisors on Science and Technology, 2012). There is clearly an increased interest in involving URM students in the STEM fields, but I think there are better justifications for this involvement than our country's global economic competitiveness. Below I've used the work from my qualifying paper to review the research carried out on the URM experience on one particular STEM pathway, pre-medicine. I hope to ultimately parallel this work using similar methods to analyze data that has been compiled on the college experience of URM students following the Computer Science track.

URMs in Medicine and the Argument for Diversity

A clear need for diversity in this specific arm of STEM (Healthcare & Biomedical Sciences) means a need for a culturally competent healthcare workforce. While an equity

argument can be made for the need for a more diverse population in these fields, a diverse knowledge base in the basic sciences and the applied research fields, is also very important for the health and well being of an already diverse society. The need for scientists and clinicians from different cultural backgrounds to create cures for, and carry out treatment on that diverse population, is very clear. URMs that study to become clinicians share some of the ethnic, cultural, and socioeconomic status (SES) experiences that many of their patients have also had. The need to diversify for the researcher and clinician pool is really a need for a better understanding of, empathizing with, and caring for patients from diverse backgrounds. As the number of URMs applying to, and graduating from medical schools in the U.S. has declined, researchers have focused specifically on the premedical pipeline that funnels URM students into medical schools (Gonzalez 2010, AAMC, 2005, Anderson, 2003, Cohen & Steinecke, 2006; Thomson & Denk, 1999).

A great deal more work needs to be done to characterize the premedical experience for students at U.S. colleges, but so far, a small number of researchers have shown that URMs in the premedical pipeline exit this pathway at a high rate, often due to inadequate science preparation and ultimately poor grades in premedical courses, and this often happens during the students' freshmen and sophomore years (Gonzalez, 2010; Thurmond & Cregler, 1999). Recent research has found that a principal reason for this URM attrition from the premedical pipeline is a loss in interest, specifically after taking courses in Chemistry (Gonzalez, 2010; Barr, Gonzalez, & Wanat, 2008).

URM and Non-URM Premedical Population

Lin et al., (2013) carried out a critical review from the earliest available date for empirical, peer-reviewed studies of U.S. premedical students. Ultimately reviewing 19

articles published between 1976 and 2010 (only 10 of which had a publication date later than 1990), they found two broad topics of classification. The clearest conclusion they were able to make was that overall, there is a paucity of current research in the area of premedical education. Lin et al., (2013), further note that in addition to many other requirements, students must do well in "weeder" classes, specifically distinguishing organic chemistry as the course which "separates the "smart" from the "not-so-smart" students" (Lin et al., 2013, p. 3). The researchers distinguished the uniqueness of the premedical experience as it stands apart from the medical experience, as participants in the premedical experience include those students who might have had an initial interest in becoming practicing physicians but ultimately did not enter the field. Studies that survey the experience of only the successful medical school matriculants are missing an integral part of the pathway overall (Lin et al., 2013).

More recent research has explored ways in which women and URM premedical students are pushed off of the medical track, by what those students consider negative experiences with pre-med coursework, specifically chemistry (Barr, et al., 2009; Barr, et al. 2010; Lovecchio et al., 2002). Significantly, in these studies students retained their interest in medicine, but stepped off of the track because of a fear of not being able to perform in premedical courses. In these cases, attrition appears as a result of academic structure, as opposed to as a loss of interest and engagement with the field of medicine (Lin et al., 2013). Lin et al., (2013) recognized from these studies the clear possibility that some groups of capable and engaged students who enter premedical coursework without the proper preparation, might be forced to abandon their aspirations of becoming physicians a bit too early into the vetting process. Lin, et al., (2013) shed light on the possibility that the premedical curriculum might be derailing candidates who otherwise might ultimately have proven to be effective doctors.

In an earlier study, Lovecchio and Dundes, (2002) surveyed a small set of 97 subjects, a non-generalizable sample of undergraduates at a small liberal arts college (nearly half of whom were former premed students), about their ultimate decision to not become physicians; while the other half filled out a questionnaire about career aspirations in general. Students who decided to leave the premed pipeline noted, among other reasons, unacceptably low grades as a deciding factor, and a large majority of those students also named organic chemistry as the one class that affected their premedical plans. Within this group 44% of the students who acknowledged their poor performance in organic chemistry as playing a role had a higher likelihood of also being disappointed about their change in career path, than the 29% of their peers who did not identify the influence of the course. Even with this small sample size the results create a good starting point for identifying specific parts of the premed curriculum that might prove to be unnecessarily derailing for students who might otherwise have the chance to become proficient physicians (Lovecchio & Dundes, 2002).

This situation is actually not new to our era as Barr et al., (2009) reviewed in a 1953 report from the National Survey of Medical Education, called 'Preparation for Medical Education in the Liberal Arts Colleges', which showed that these introductory science courses had often been used to prevent underperforming students from, ''cherishing inappropriate professional ambitions too long'' (Barr, et al. 2009; Severinghaus et al. 1953, p. 11). The 1953 report went on to note that many students were ''weeded out'' in this manner as the result of, ''an unduly tough attitude on the part of many chemistry teachers who claim with pride that only students of good ability who work very hard can get through their chemistry course'' (Barr, et al. 2009; Severinghaus et al. 1953, p. 11). Barr et al., (2009) note that the authors of the 1953 report criticized this gatekeeping process: ''...it is surely bad educational practice for one teacher, or one department, to act as a self-appointed obstacle", going on to state that it should "not be permitted to continue'' (Barr, et al. 2009; Severinghaus et al. 1953, p. 11). These statements are

intriguing, firstly, because while observations were made about individual teachers and individual departments, even at that time this pedagogical philosophy seems to have permeated across the country to some of the most selective universities. Secondly, while this report was made in the early 1950's by authors and researchers that were noted to be representative of some of the leading medical schools throughout the country, there is little evidence that any action was taken to remedy this problematic, pedagogical practice. This mentality seems to have existed long before the 1950's and seems to continue to bar students from finding success on their paths to medical education even today. The professors at these institutions have clearly had to be proficient in their fields, to compete and to publish to attain their faculty positions. As many of the faculties at selective institutions are not diverse by SES, race or ethnicity, many professors in STEM fields do not necessarily have exposure to, or understand the experience of URMs in STEM, and therefore would be challenged in trying to empathize with these students to understand their learning needs or to explore alternative forms of useful pedagogy. Therefore over the course of decades, curricula have not changed, teaching practices have not changed, and the students that are best suited for this instantiated structure of learning, continue to be the students that find the success in these arenas. Many professors are well equipped to teach students that have become well practiced during years of schooling at highly resourced elementary and secondary schools, while what the academy would consider unprepared students are left to struggle through classes that are branded as introductory or remedial.

I would speculate that if I asked an organic chemistry professor today whether or not he applied this gate-keeping or weeding out process to his courses, I would expect him to be politically correct, whether he believed in the gatekeeping process or not, he would most likely deny applying it. While Grumbach and Mendoza, 2008 note that the weeding out process continues at both public and private institutions, I've not yet been able to find journal articles that qualitatively characterize or measure this process of weeding. Even if

present introductory sciences professors do not actively weed students out of the pipeline, the antiquated pre-medical curriculum, the status quo that the current STEM faculties continue to endorse, and the institutional bureaucracy that slow a university's ability to change and evolve, instead combine to do the weeding of many URM students.

Focusing on this portion of the pipeline into medical school for URMs rather than the larger period that students spend in K-12 education seems fruitful. Grumbach & Mendoza, (2008) point to the extremely low growth in enrollment of URMs in medical schools during a decade in which URMs graduating from colleges in the U.S. increased. They note that focusing on the college portion of the pipeline has been attractive to stakeholders and funders, as it takes less time to note the outcome of an intervention. Thus far these stakeholders however seem to focus on programs that parallel the traditional premedical education in college. In my review of the current research, I've found the existence of multiple post baccalaureate programs, as well as summer bridge programs (programs during the summer before a student's freshman year) that prepare a number of URM students to better perform in their premedical classes in college, or better perform when they take the classes or repeat the classes in a program after college. Programs include the UCSF Medical Scholars Program, The San Francisco State University Post Baccalaureate Program, and U.C. Berkeley's Extension Post Baccalaureate Program.

At the university level funding is often channeled to recruitment and retention, and equal opportunity programs designed to help students entering higher learning in many cases by way of under resourced high schools. Many programs like the Leland Scholars program at Stanford or the Summer Bridge program at UC Berkeley focus on exposing students to a condensed short-term curriculum that covers study strategies and time management, as well as topic related introductions to challenging subject areas like chemistry. In other words, a lot of energy is put into creating an adjunct to assist with the courses rather than

improving the original courses themselves. Professor Carl Weimann's lab at Stanford has generated research on introductory course redesign and improvement within the specific field of introductory physics (Holmes, N.G. & Weiman C. E., 2018). But thus far I have found little research that focuses on changing the wider scope of premedical focused university curriculum itself; that is improving upon how introductory STEM courses that are taught specifically for the premedical student in college. Barr et al., (2009), note that the premedical curriculum defined by the Council on Medical Education of the American Medical Association has not seen any substantial change since its inception in 1905. Improvements in the premedical education curriculum might be able to help URM students by giving them the opportunity to experience effective teaching and learning while they are actually in college and paying tuition for their courses.

Gonzalez et al., (2010) pinpoint chemistry as the linchpin of the premedical challenge, as women and URM students with an early interest in being pre-med identified chemistry as the course that most discouraged them from continuing on the path to medical school. In fact, Gonzalez, et al., (2010), go so far as to challenge the necessity of organic chemistry as a premedical requirement at all, noting that multiple researchers before them have agreed that the course has little predictive power when it comes to students' ultimate clinical practice, and that the course, as many of the other premedical courses are far removed from the knowledge necessary to understand human biology (Barr, et al. 2009; Veloski et al. 2000; Donnon et al. 2007; Basco et al. 2000; Violato and Donnon 2005, Dienstag 2008,). Barr et al., (2009 and 20010) surveyed incoming freshmen at Berkeley asking them if they were interested in a future career in Medicine, and if so, to rate their interest by Likert scale. They then re-contacted those students at the end of their second year asking them to re-rate their interest and compared the mean responses across the five principal ethnic groups at both time points, and then compared the change for each group. The researchers then separated respondents into URM and non-URM groups and randomly selected nearly equal numbers from each group to do a follow up interview,

both at the end of their second year and the end of their fourth year at college, asking them which factors affected their interest in pre-medical studies, as well as what specific courses had discouraged that interest (Barr et al. 2009).

In this, Chemistry appears to be the most discouraging course for 71% of URM students mentioning a course, and 55% of non-URM students mentioning a course. And for both groups chemistry was noted four and five times more often than the next courses, leading the researchers to believe that chemistry was the most discouraging factor for students at Berkeley, as students began their college careers as pre-meds. Only one of the 29 URM students interviewed reported that none of their courses discouraged their interest in pre-medical studies, while more than a third of the non-URM students noted that no classes discouraged their interest, leading the researchers to hypothesize that chemistry at Berkeley was a greater deterrent to premedical studies for URM students (Barr et al. 2009). And in asking this question they looked for any mention "of a course that was so discouraging, that as a result of having taken it, the student may have changed his or her aspirations regarding a career in medicine. (Barr et al, 2009 pp. 50). Significant that this was how so many of these undergraduate students, just from one introductory course, ultimately viewed both chemistry and their earlier proposed career as physicians.

Barr et al., (2009) concluded that early experiences with chemistry appeared to be the principal cause of a decreased interest in continuing as a pre-med student, and that these discouraging effects appeared to be more acute for URM students (Barr et al., 2009). Although not to the same extent as URM students, non-URM students were more likely to be discouraged by chemistry than their other science courses as well (Barr, 2009). The conclusion the researchers made that seemed most significant, was that for URM students, their experience with chemistry lead directly to their questioning their ability to continue pursuing a career in medicine, and then stopping their pursuit of the career entirely. Barr et al., (2009), further postulate that this strong reaction may be due to URM

students' earlier experiences in under-resourced high schools that did not prepare them for such strenuous science courses. They also noted that a great majority of the URM students in the study were women and therefore had a higher chance of being disadvantaged by science, elementary and secondary school curricula (Barr, 2009; Seymour & Hewitt, 1997).

A Group of Students that Continues to go Unrecognized

Research findings that substantiate URM students' early interest in Medicine as they enter college, but feelings of discouragement as they carry out coursework in chemistry, is discouraging as it shows to some degree that the problem is not a lack of interest in medicine, it's a bad experience with what can be considered a limiting curriculum design. While it is a reasonable alternative strategy to reach out to children at an early age in school, to help them gain the foundational knowledge necessary to succeed in these fields, while also trying to spur interest and engagement, there is a clear population of URM students that are already at the higher learning level, starting their college careers with their sights set on very specific STEM careers such as Software Engineering. These students might be entering college already engaged with and invested in STEM, but might not have the prior knowledge or experience necessary to perform well in introductory STEM classes. This is a population of students whose experience needs to be further characterized as they are currently going unnoticed. While university administrators ask the question "what can we do to get more URMs interested in STEM," they are ignoring those students that are already highly engaged in and enthusiastic about careers in these fields. It is clear that there is a large URM population of college students who are dedicated to becoming the first doctors in their families, pursuing a highly esteemed career, hoping to ultimately give back to their communities. So while much of the rhetoric is currently focused on engaging URM students in STEM learning at an early age, there are URM students making it into college who are already engaged and enthusiastic about STEM careers like Medicine, yet are unable to make it past gatekeeper

courses, and ultimately need to change majors. It continues to be difficult to gauge the size of this group, as incoming students do not have to declare pre-med or STEM majors, so I would expect that many students on this track never have an opportunity to make their interests known, before they change major or career directions.

Given this, an important research question becomes: at what rate are universities losing URM students due to these introductory courses? Proxies can be used to answer this question, but there is a very strong chance that these estimates will have a large degree of error, as an interest in these tracks can go entirely unsaid for many students. Additionally, if URM students are changing majors, to which majors are they switching? The Department of Education created College Scorecard in an apparent hope to provide some transparency for students as their families invest a great deal of money in their educations. On the platform, Stanford University has a graduation rate well above the national average at 95% (U.S. Department of Education, 2015). But what percentage of those graduates earned degrees in areas that were initially less engaging and interesting to them than the STEM degree they entered college hoping to complete? While the majors these students ultimately settled on, most likely were fulfilling, engaging, and set them up for successful careers, what might those students, and the fields of research and practice themselves have lost, when these students abandoned their initial passions and interests? Assuredly College Scorecard gives the ethnic breakdown of Stanford's student body, as well as a percentage breakdown of what the Department of Education calls the most popular programs; popular is defined as the five largest programs of study, as measured by the number of degrees awarded. Stanford has 7% of the student body gaining degrees in Biological and Biomedical Sciences, a degree common to premedical students (U.S. Department of Education, 2015). However, what percentage of the student body used to be highly interested in getting this degree but due to challenges in introductory courses, chose an alternative pathway? Stanford and universities like it might have a high rate of

graduation, but these institutions also clearly have a low URM rate of graduation with degrees in STEM. These are missed opportunities to give enthusiastic young students the opportunity to pursue a field that they have love and passion for. It is just as important to know the rate of students who begin work on a degree in biomedical sciences with hopes of becoming pre-med, find that they cannot perform well in gate-keeper classes, and leave their dreams of becoming a clinician behind, as it is to know that same school's graduation rate when choosing where to study.

I am less concerned with the student population who've taken introductory STEM courses and simply become disinterested in the area. I am instead concerned with the students who struggled in these courses, could not find a way to perform well, and ultimately gave up. This study is further grounded in my own struggles with introductory STEM courses as an undergraduate student pursuing medicine. In fact the best anecdotal example I can give is my own. Early on in my own Cell and Molecular Biology education a Physics professor of mine vehemently argued that *some people are not meant to learn Physics and that I might be one of those people*. I however took this feedback and went on to matriculate to the UCSF School of Medicine. Additionally, as many academic advisors are focused on supporting students so that they can complete degrees, and complete them in an affordable period of time, those advisors suggest changing majors and relying in some cases on the writing skills and other proficiencies, which got many URM students admitted to college in the first place. Additionally the tutoring centers on campus can be under-resourced themselves and not necessarily prepared to support students from similarly under-resourced high schools that don't have the introductory or foundational skills and knowledge necessary to perform at the same level as their student counterparts. At the same time many URM students know first hand that attending office hours at a competitive university does not always provide support for students that need a great deal of review in foundational concepts. One URM student here at Stanford told me

that he felt the most savvy and intelligent students, were also the students most often attending office hours, rather than the students that needed the most help with foundational concepts. Therefore he constantly felt stigmatized asking questions that were below what he felt was his peers' level of understating and performance in the courses. Lastly, discrimination is also a challenge in these environments as one woman I spoke with that studied Computer Science at Davis explained that whenever she visited office hours for her engineering courses, she felt that as the only woman in attendance her questions were ignored by her professors on multiple occasions. Master et al. demonstrated that cues indicating that girls are welcome and belong in a high school computer science environment, can actually increase girls' self-reported interest in computer science, despite prevailing stereotypes (Master et al., 2016). The researchers found that at the high school level, intentionally designing the classroom to communicate that girls actually belong has the propensity to reduce gender disparities (Master et al., 2016). But in a situation like the young woman from Davis experienced, it's clear that being inclusive at least to the level that one's questions are recognized and answered, is a necessary first step, not just to boosting her interest, but at its basest level, giving her a fair chance to advance in her studies as the men around her had been given.

A student's inability to perform well in gatekeeper courses, confounded with the amount of stress that comes from not feeling as intelligent as her peers or able to compete with them, can trigger stereotype threat, and further feelings of being an imposter. Taken together all of these factors can completely skew a student's interpretation of why she remained on or strayed from the path to a STEM major, or the pursuit of a career that focused on science. "Stereotype threat theory proposes that the performance situation, infused with cues about the devaluation of one's social identity, creates an extra burden for individuals from stereotyped groups, undermining their performance in the stereotyped domain" (Steele, C. & Carr, P., 2009, p. 853). The decades-old rhetoric that

faculty created around a student's experience with gatekeeper courses; the idea that if you cannot excel in introductory science, you'll be ill prepared to be a physician, needs to change, and I believe that that change begins at the interface between the premedical class and the premedical student. For more URM students to find success in this STEM education pipeline, either the courses are going to have to change, or the way that students engage with the courses is going to have to change. Seldom will you hear a student that is finding success in a course, performing well, understanding the material and getting good grades, then complain about the course they are taking. Very seldom have I heard a student say, I'm really good at *X* field, so I'm going to switch directions and major in something different to avoid it. We need to find ways to help struggling students find success in these introductory courses so that they no longer go unnoticed, and can ultimately achieve the goals they set out to achieve upon entering college.

This study explores why URM students are falling out of the STEM pipeline unnoticed. It explores those students who started off with high aspirations to become Doctors, Software Engineers, or to seek doctoral degrees in the Sciences, but found challenges at the early stages of their educational tracks too much to deal with, and then switched to degrees in the Humanities or the Arts, ultimately graduating to pursue entirely different careers. Universities such as Stanford deem their efforts to graduate these students in these alternative fields a success. While these students rightly deserve congratulations for the huge amount of work they do to complete their degrees, they also deserve the chance to pursue a passion, desire, and interest in STEM if they so choose. The curriculum design in these introductory classes is antiquated, often not based on current pedagogy and learning sciences research, and the professors and administrators in control of this course design are often more worried about carrying out research (what their administration is better at supporting) than modifying their teaching style to reach

students at the level of understanding and proficiency, with which those students are entering college.

Many of the introductory STEM classes at U.S. colleges have been characterized as gatekeeper classes, those classes with an antiquated curriculum designed decades ago, hardly modified since, which weed students ill prepared to deal with such a rote curriculum, out of the STEM-student pool, and entirely out of the pipeline into STEM careers. Many of the professors that teach these courses are highly focused on competing as active researchers in their fields, have had no experience or training in pedagogy, cannot meet this population of students at their experiential level or STEM knowledge base (although these are introductory classes), and therefore close the door on actively engaged students' hopes of following their dream careers. As the students taking these introductory courses tend to be within their first two years of college, poor grades and performance in these courses threaten their ability to secure scholarships, and lack of financial aid funding threatens their chances of remaining in college and ultimately graduating at all.

Orienting Framework

This study analyzes data generated by the Academic Pathways Study (APS), conducted by the Center for Advancement of Engineering Education (CAEE) (Clark et al., 2008; Sheppard et al., 2004). A major goal of the APS program was to unearth challenges that students face in engineering programs that hamper their persistence, challenges that slow or block them from completing degrees in engineering, and ultimately from pursuing careers in the field. Matusovich et al. (2010) one of the many groups of researchers that analyzed and published their insights on the APS data, applied expectancy-value theory, a facet of Eccles' motivation theory (2005, 2007; Eccles et al., 1983) to a small group of

case studies, which they created from data collected from 11 students of white, asian, latinx, and mixed race descent. I connected my analysis of the data to Matusovich et al.'s work because their work used an established framework and analyzed very rich qualitative data with that framework, to look for themes and patterns. According to Matusovich, et al., (2010) Eccles' expectancy-value theory posits that the choice to pursue a degree in engineering is formed by value and competence beliefs that an individual student holds about themselves and the field of engineering itself. "Competence beliefs address questions of ability, "CAN I do this task?" and value beliefs consider the personal importance of a task, i.e., "Do I WANT to do this task"" (Matusovich, 2010, p. 298). "Consistent with the tenets of social cognitive theories, Eccles' model is based on an individual's perception of his or her abilities and task values that shape engagement and persistence behavior; importantly it is not his or her actual ability or task completion that is important" (Matusovich, 2010, p. 290). Expectancy-value theory is defined by four value categories: interest, importance, cost, and attainment. It's posited that these values then characterize the ways in which an individual assigns importance to an activity (in this case pursuing an engineering degree and career) (Eccles, 2005). Matusovich et al., aimed to answer the question, "how do engineering students' engineering-related value beliefs contribute to their choices to engage and persist in earning engineering degrees" (Matusovich, 2010, p. 298). However, none of the students that they created case studies for identified as Black or african american. "Since motivation theories attempt to explain the process whereby individuals choose and continue to engage in activities, they have the potential to facilitate a move from describing characteristics of persisters and non-persisters to explaining how and why persistence happens" (Matusovich, 2010, p. 290). This analysis will attempt then to shed light on the process whereby Black students at an Historically Black College & University (HBCU) choose to persist, and why they choose to persist.

According to Stevens et al., Lave and Wenger "highlight that learning involves more than the acquisition of skills and knowledge, but also involves changes in what types of people we become and in how someone understands him or herself in relation to a particular disciplinary practice" (Stevens et al., 2008, p. 357). But the establishment of a student's identity is two-fold, the individual's definition of their identity, and how they are identified by others in their personal, work, and school lives. Stevens et al. therefore describe this identification practice as a "process of positioning ourselves and being positioned by others" (Stevens et al., 2008, p. 357). In their work they focused on "two key issues: (1) how engineering identities develop over time, stabilizing within the double-sided process of specific acts of identification, and (2) how the differing forms of accountable disciplinary knowledge in engineering education, position people differently in terms of their identifications with engineering" (Stevens et al., 2008, p. 357). Stevens et al. describe some of the differences between Urban Private University (UPri), the university from which all interviews are taken in my analysis, and the other universities that data was collected from.

> At Urban Private University (a historically black comprehensive research university), the risks were of a different kind than at Technical Public Institution and Large Public University. Some students felt compelled to leave engineering, even though they identified with it, because the stringent grading standards might lower grade point averages (GPAs), threatening a scholarship that enabled students to be at Urban Private University in the first place (Engerman, Fleming, and Williams, 2006). In summary, differences in the local cultures at each of the four schools were associated with complex and different relationships between being at the particular university and being in engineering (Stevens et al., 2008, p. 361).

Additionally there may well be a strong connection between the four value categories of motivation described by Eccles' framework, -interest, importance, cost, and attainment- and the role that identity plays as it affects each of these four values in the motivation framework. Added to this is the notion that identity is something that is defined by oneself and one's community and environment, as described by Lave and Wenger below.

> The person has been correspondingly transformed into a practitioner, a newcomer becoming an old-timer, whose changing knowledge, skill, and discourse are part of a developing identity – in short, a member of a community of practice. This idea of identity/membership is strongly tied to a conception of motivation. If the person is both member of a community and agent of activity, the concept of the person closely links meaning and action in the world (Lave and Wenger, 1991, p. 69).

Case Study Focus

For this work I employed case study methods to test how identity and expectancy-value theory factored into the experience of six African-American students majoring in Systems and Computer Science, Computer Engineering, and Electrical Engineering. "Case study research differs from other forms of qualitative research, such as ethnography and grounded theory, because case study research tests existing theory" (Matusovich et al., 2010, p. 291). While Matusovich, et al. carried out a similar analysis on students in 2010, unfortunately none of the researchers used data from students that identified as African American or Black . Within my analysis I explore the cost not only of being an engineer, but also the cost of being an engineering student, and understanding this from the perspective of underrepresented minority students is important for

educational researchers and educational administrators to understand, so that researchers and administrators can better serve these students. Therefore this analysis is an attempt to replicate aspects of the aforementioned study, while also trying to build on that analysis by specifically exploring the experiences of underrepresented minority students pursuing similar goals. Matusovich explains that case study research is oft employed by researchers "to understand events or social systems while maintaining the realistic characteristics and details of such systems or events" (Matusovich et al., 2010, p. 291). Matusovich et al. have mainly non-URM data, and this is part of why the contributions from my analysis are impactful.

The data I've analyzed were collected in the Academic Pathways Survey (APS), a research project that included four longitudinal cohorts of students across 5 different universities, where the researchers used a variety of research methods, including semi-structured interview, survey, and ethnographic interviews. The primary goal for the longitudinal cohort analysis was to "identify and characterize the pathways and decisions involved in becoming an engineer" (APS, 2010, p. 3), and therefore the work was focused on four categories of research questions:

1. How do students' engineering skills and knowledge develop and/or change over time?

2. How does one's identity as an engineer evolve? More specifically, how does student appreciation, confidence, and commitment for engineering change during the undergraduate educational experience? How do these changes impact student decisions about pursuing engineering after graduation?

3. What elements of engineering education contribute to the students' skills/knowledge and identity? What do students find difficult and how do they deal with the difficulties they face?

4. What skills do early career engineers need as they enter the workplace? Where did they obtain these skills? Are any skills missing?

While the researchers' intention was to include students from diverse backgrounds in the study, thus far only a small percentage of the works published have focused on the experience of underrepresented minority (URM) students, even though this focus was a key element of participant recruiting and the overall research plan. In the Longitudinal Cohort specifically [as well as the Broader Core and National Samples], the researchers "employed oversampling strategies for gender (male/female) and underrepresented minority students, including African American/Black, American Indian/Alaska Native, Mexican American/Chicano, Puerto Rican, other Latino groups" (APS, 2010, p. 7). Matusovich et al. cite Stake's (2006) case study analysis "suggestion of five to fifteen cases to insure sufficient but not overwhelming quantity of data" (Matusovich et al., 2010, p. 292) and that is in part, why my current analysis will include six case studies on Black students from UPri.

Urban Private University (UPri) was an approximately 10,000 student large, comprehensive, Historically Black College & University (HBCU). "In 2004-05, approximately 1400 were freshman, with 180 entering the engineering program each year. Freshmen are accepted into the engineering program upon enrollment" (APS, 2010, p. 6). These engineering major estimates were comparable to those made by the American Society for Engineering Education for both the 2003-04 and the 2006-07 academic years as seen in the tables below.

Table 1: UPri's 2003 Undergraduate Enrollment in Engineering Majors by Class

Enrollments by Class

Undergraduate Engr. Departments	Fresh 1st Year	Soph 2nd Year	Junior 3rd Year	Senior 4th/5th Year	Part Time Total	Full Time Total
Chemical Engineering	14	17	20	19	1	70
Civil Engineering	21	17	8	17	2	63
Electrical Engineering	46	28	31	41	7	146
Mechanical Engineering	25	13	12	24	4	74
Systems & Computer Science	36	37	44	46	6	163
Totals:	**142**	**112**	**115**	**147**	**20**	**516**

American Society for Engineering Education

Table 2: UPri's 2007 Undergraduate Enrollment in Engineering Majors by Class

Enrollments by Class

Undergraduate Engr. Programs	Fresh 1st Year	Soph 2nd Year	Junior 3rd Year	Senior 4th/5th Year	Full Time Total	Part Time Total
Chemical Engineering	19	25	10	18	72	2
Civil Engineering (B.S.)	13	10	13	11	47	2
Electrical/Computer Engineering (B.S.)	33	24	27	29	113	18
Mechanical Engineering (B.S.)	30	19	14	17	80	3
Systems & Computer Science (B.S.)	19	7	9	10	45	1
Undetermined	0	0	0	0	0	0
Totals:	**114**	**85**	**73**	**85**	**357**	**26**

American Society for Engineering Education

From each school a sub-group of Longitudinal Cohort participants was deemed the high contact group, and monickered the "Ethnography group, the Ethno 8" (APS, 2010, p. 10), as these specific participants were also studied using ethnographic observations and semi-structured ethnographic interviews. I analyzed data on six students, attending a Historically Black College and University, which we refer to as UPri, between the fall semester of 2003 and the spring semester of 2007. These specific students were selected based on the fact that there was ample data available from their interviews, and their declared majors all fell into a similar category, which included computer science, computer engineering, and electrical engineering. Each of the six participants represents

an individual case and each case was analyzed separately before being compared in an analysis of the overarching themes, taken as a whole to describe a component of the engineering major experience at UPri during this period. While Matusovich et al.'s (2010) analysis focused on ratings from school year to school year, this analysis did not. As there was some variation in what interview school years were available, the six participants' experiences across different school years was not the focus of this analysis. The focus was rather, an attempt to get a broader picture of the students' multi-year experience at UPri. Additionally, there were cases in which an interview was carried out during a student's junior year of college, in which they spent a lot of time speaking about their experiences sophomore year or vice versa, so the data although compiled from a certain year would many times bleed into experiences from a different year, or a set of interviews across different years would each reference the importance of activities carried out in one particular year. Of the in-depth interview data available, this analysis focused solely on Black students as students from this racial and ethnic background are currently underrepresented in the wider body of analysis thus far completed on the APS data. In an attempt to achieve a gender balance, four self identified females' data were analyzed and two self identified males' data were analyzed. None of the data accessed in this analysis of APS included participants that identified as gender non-binary. Therefore gender non-binary cases were not included in this analysis, and gender was therefore not balanced across the non-binary spectrum. Additionally, to review data on majors within the scope of computer science engineering, my focus was on two students majoring in Systems Computer Science, as well as three Computer Engineering, and one Electrical Engineering major. It's common for universities in the U.S. to house computer science, computer engineering, and electrical engineering in the same department, and in 2003 UPri's major Computer Science department was named 'Electrical Engineering and Computer Science', with majors focused on producing graduates that would ultimately become electrical engineers, computer engineers, and computer scientists ("UPri.edu," n.d., para. 4). Additionally, each of the six students in this study was ultimately classified as a persister, in that they both entered UPri with an intent to study

engineering, and ultimately their declared major at the end of the study period was also in the school of engineering. There are a total of 14 ethnographic interviews for the six participants included in this analysis. As a transcriptional convention I've included direct quotes from transcriptions, including non-standard grammatical forms to consistently represent the natural language used by each participant, and remain true to their words as stated. All names referenced in the analysis are pseudonyms.

Main Constructs

Stevens et al. emphasize that learning sciences often overlooks the importance of the creation and stabilization of an *identity* as a specific type of disciplined person, i.e., becoming an engineer (Stevens et al., 2008). Lave and Wenger "highlight that learning involves more than the acquisition of skills and knowledge, but also involves changes in what types of people we become and in how someone understands him or herself in relation to a particular disciplinary practice (e.g., engineering)" (Stevens et al., 2008 p. 357). An individual's identity is dependent upon both how they identify themselves and how they are defined by others in their social networks, by their classmates, colleagues, friends and family (Stevens et al., 2008).

Holland et al., described this double-sided process of identity as, the ways in which we position ourselves and "the ways that a person is positioned by other people and institutional practices" (Stevens et al., 2008 p. 357). Stevens et al. use a more specific formulation of the identity concept, which has also been applied to this analysis. In contrast to referring to the abstraction of *identity*, Stevens et al. focus on what they call the *practices of identification,* and then abbreviate this construct as *identifications* (Stevens et al, 2005). The researchers note that "identifications are empirically tractable (e.g., "when I am an engineer"); we can see and hear the ways that people do or don't

identify with others and with particular activities associated with the discipline of engineering and engineering education" (Stevens et al., 2005 p. 2). As with the Stevens et al. work, this analysis also explores how a student's identifications over this four year period culminate to become "a stable sense of one's self or a stable position with the particular social world that makes up engineering", or a combination of both (Stevens et al., 2005 p. 2).

In addition to an analysis of identifications, this analysis also delves into personal motivation, and how it relates to students' pursuit of an engineering career while enrolled in a university program. Matusovich et al. developed operationalized (aka 'measurable') definitions that corresponded with Eccles' value categories, and which were reflective of their participants' perspectives. These are the aforementioned value categories: attainment, value, cost, interest, and utility.

Attainment

Eccles (2005) defined *attainment* value as "the value an activity has because engaging in it is consistent with one's self-image" (Matusovich et al., 2010, p. 294). Matusovich et al.'s operationalized definition centered the student's activity on "choosing an engineering career" (Matusovich et al., 2010, p. 294). In this case, they defined *attainment value* as "a reason for pursuing (or not pursuing) engineering that is related to being the type of person who is an engineer" (Matusovich et al., 2010, p. 294). The example they give is "I am a problem-solver and engineers are problem-solvers."

Cost

Eccles' definition of *cost* is "the price of success or failure in terms of effort, time and/or psychological impacts", and Matusovich et al. add "of pursuing engineering or another career", giving the opportunity cost example, "being an engineer means not being able to pursue interests in art" (Matusovich et al., 2010, p. 294).

Interest

Eccles' *interest* is "the enjoyment experienced in doing the task", Matusovich et al.'s task being refined to, "doing engineering activities and/or becoming an engineer in the future" (Matusovich et al., 2010, p. 294). The example they offer is, "engineering is the career name for the hobbies I enjoy" (Matusovich et al., 2010, p. 294).

Utility

Lastly, for Eccles *utility* is "the perceived future direct or indirect importance of engaging in the task". For the world of engineering that task might be *becoming an engineer*. Matusovich et al. modifies *importance* to "the perceived usefulness or lack of usefulness", of for example "being or becoming an engineer and/or earning an engineering degree" (Matusovich et al., 2010, p. 294). Matusovich et al.'s last example of utility is "engineers are well paid" (Matusovich et al., 2010, p. 294). Matusovich et al., then rated each participant (based on frequency and quality of the codes) by value category, year to year as high (H), moderate (M) or low (L) (Matusovich et al., 2010). 'High attainment' to the researchers meant that engineering was consistent with the student's sense of self, 'high cost' meant sacrificing to become an engineer, 'high interest' meant enjoyment of activities that students associated with engineering, and lastly 'high utility' meant perceived usefulness of a future engineering degree (Matusovich et al., 2010). The following student-focused sections are made up of an

introduction to each student, a description of many of the experiences they shared, as well as a review of how the main value constructs intersect with their stories.

For Matusovich et al., six students chose to both engage in and persist in earning engineering degrees, and those participants' reasons always connect to an attainment value, i.e., a sense of self" (Matusovich et al., 2010, p. 296). The researchers use this analysis in support of the Eccles construct that attainment value can be defined as "how important one perceives a task to be and how consistent that task is with his or her sense of self (Eccles, 2005; Eccles et al., 1983; Wigfield and Eccles, 1992)." (Matusovich et al., 2010, pp. 296-297). And they go on to operationalize this construct by stating that "attainment values are reasons for pursuing (or not pursuing) engineering degrees that are related to perceptions of the self as an engineer" (Matusovich et al., 2010, p. 296-7). Student profiles like those of Monica, introduced below, challenge the cleanly-bucketed student analyses depicted in Matusovich et al., 2010. Whereas, Monica describes herself as well equipped in mathematics, and as a strong problem solver, she finds little interest in the detail-oriented practice of coding, where one comma can ruin 600 lines of code. "You could miss one comma, write the whole program, you know five hundred, six hundred lines of code or something and at the end of it you're sitting here debugging it for two weeks because you missed one comma because you didn't do it in a specific way." Nonetheless, she references multiple experiences over the course of three years, where she was the only member of a project group or student organization that was able to manage her team and keep them on task to complete their projects. Proficiency of practice with mathematics and coding tools, and a high-level understanding of how to execute on an engineering project plan, as well as the communication skills to get other engineering students to follow her lead, all seem to be valid characteristics of an engineer. Yet Monica finds she tires of the practice of coding, and therefore becomes disinterested in being an engineer. Some of the tasks that she describes are strongly consistent with her sense of self, practicing mathematics and problem solving, while

others are not consistent, like coding. Monica equates engineers with problem solvers, and describes that along her educational path, the strategy that she employed to find success and keep a high grade point average (GPA), was to actively solicit the advice of more senior students, as well as make the decision to drop courses taught by unreasonably difficult teachers one term, and instead return to the courses during a term in which another teacher is available. Where then does Monica fall in terms of attainment? These are examples of problem solving and technical skill common to engineers, which therefore can be classified as attainment. A student may believe that engineers are good problem solvers. Such a student as Monica, might apply a specific strategy to the timing and sequencing of her courses, so that she chooses major requirement classes that allow her to perform well. In this case she can view herself as a problem solver, and equate the quality of being a good problem solver with her potential to be a good engineer.

"According to Eccles (Eccles, 2005; Eccles et al., 1983; Wigfield and Eccles, 1992), *cost* is the time, effort, and psychological price of succeeding or failing in a given task. In Matusovich et al., 2010, "costs associated with being an engineer or not being an engineer in the future are considered" (Matusovich et al., 2010, p. 297). Matusovich et al. also make a distinction between the the costs of being a practicing engineer, from the costs of being an engineering student (Matusovich et al., 2010). To focus solely on costs associated with being a practicing engineer they distinguish "heavy course loads or the emotional and psychological toll associated with the financial burden of paying for engineering courses", from the costs that might be associated with the work-life balance of a practicing engineer (Matusovich et al., 2010, p. 297). And the researchers choose this focus because they feel that they cannot distinguish between data that describes the cost of studying engineering, from the cost of studying another major at a competitive college or university. They argue that the challenges that the students "mention could be

associated specifically with being engineering students or they could be associated with attending a competitive school..." (Matusovich et al., 2010, p. 297-8).

Yet Matusovich et al.'s focus on the costs of being an engineer alone, would be limiting for the current study for two reasons. First, many of the students interviewed spoke to challenges that were directly related to being an engineering student, and distinguished these challenges from either their experience in other non-engineering classes, or the experiences of their peers in these non-engineering classes, and the major-related cultural practices of engineering students and non-engineering students. Secondly, because these students have only studied engineering rather than practiced it, they have a great deal more insight into what it means to be an engineering student than what it means to be in an engineer. Matusovich et al.'s student-subject Julie, provides a perfect example of this experiential stance. She explains that she would rather pursue a career in teaching so that she has more freedom to pursue her hobbies of dance and drama as well, and believes that a career in engineering will not allow her to do this (Matusovich et al., 2010, pp. 298). This is a very inexperienced estimation of what the two career tracks, teaching and engineering, will allow a professional to practice in their free time. Aside from anecdotal answers like this one, the curricula of many STEM majors is far from representative of what work-life in that field will be like. Therefore, as a refinement of Matusovich et al.'s definition of the value of cost, the analysis of the present study will focus instead on the cost associated with being an engineering student in addition to pursuing an engineering career, as they are both part of the continuum of engineering practice, and the cost of pursuing the training and education necessary to become an engineer are as significant as the cost of practicing engineering (Matusovich et al., 2010).

Narratives and Analysis

What follows below is an individual narrative for each of the six students that I selected for the analysis. I've attempted to keep some of the chronology and organization of the way in which the interviewer elicited their story, and I've given as many details as possible about the context and data points that surround the principles of identity, interest, attainment, cost, and utility. Extensive quotes in the students' own words are included as I've tried to design a picture that best represents both their challenges and accomplishments, leading up to and during their time at UPri. After the group of narratives, I've then devoted a section for each student that sums up their experience based on these identity and motivation values, shared additional insights that arose from this analysis, and described the two largest takeaways generated from looking at the student experiences as a whole.

Monica

Monica a computer engineering major from Park, Illinois, has friends and colleagues who automatically assume that she is not in the engineering department, as they often explain to her, she is actually sociable, outgoing, and cool. She's on the executive board of multiple student organizations where she works as an adept communicator, able to lead large and diverse teams to execute on the organization's highest priority goals. Surprisingly, Monica does not however equate any of these specific abilities of communication and leadership with the practice of engineering, and therefore struggles to see herself ultimately working in the engineering field. This is all the more surprising because she achieves nearly straight As in her coursework, and sees herself as very proficient in math and problem solving in these courses.

We begin with a short anecdote that best describes our first student Monica's perspective of her identity. Monica is a computer engineering major that perceives herself as a proficient and intelligent engineering student, and a very social being, and we see that her classmates and colleagues express a pretty similar interpretation of those two facets of her identity. Monica states,

> I'm not typical, because like when people meet me and I say engineering, they're like, "You're joking?" And I'm like, "No I'm an engineer," or whatever. And nobody ever believes me because it's like-, I don't know what-... and then people meet my like, "Girl, you're joking," you know like, "I'm kiddin-, I'm not joking!" You know they're like, "Well what are your grades like?" You know like, "Well, you must not be a smart one or whatever," but I'm like, you know I got-, you know, I got all A's and one B, you know like I'm, "I'm smart fool." And I'm like what is it that's not, nothing you expect me as an engineer, you know?... And this happens to me in a conversation I had with one of my friends and they were... saying something about engineering, it's like well, "How many engineers, cool engineering students do you know but her?" And they were like pointing to me, and I'm like, "Wait a minute… I don't know, maybe they're serious-, and I'm very serious too so um maybe my personality, um, I don't know what it is, um, the way they study, I study a lot too though... well the people I see, engineers tend to be like very reserved…

Her social nature is only one of the many qualities that makes Monica stand out from her peers. She notes that her father is an engineer, but doesn't describe his speciality or where her father's experiences factor into her interests. Yet as early as high school, she learned Cisco (to become a Cisco Certified Entry Network Technician) and noted that she could have passed the certification exam if she had only taken it. She came into UPri feeling very proficient in math and seemingly unphased by many of the challenges with technical

knowledge that students often face in introductory STEM courses. Monica noted that she chose the University long before choosing her major, since gaining admission to UPri in her family and her surrounding community, meant that she'd already achieved great success. Monica noted that she'd always been interested in technology, and chose the Computer Engineering major purely due to the fact that the title started with the word *computer*. And this was a telling marker, because she ultimately found that she had no interest in, and no passion for the attention to detail needed to avoid one mistaken comma blocking the successful execution of 600 lines of code. Ultimately, Monica criticized engineering as a major, for requiring her to spend late nights studying in the lab till 7 in the morning, to then have to take a brief trip home to shower before her 8am class began. The passion for the subject was simply not there for her, although she persisted nonetheless. She described herself as a person that had to put 100% into everything that she chose to do, so when she began to realize in her junior year once she'd finally had the chance to start taking upper division classes in her major, that she had no passion for the field and it was too late to switch majors to something like economics, business, or information systems. Monica resolved to put her energy into seeing the major through, and continue to achieve competitive grades in her courses as she completed the major. Through all this, she never spoke with disdain about the program or the field of study itself though, as she seemed to find her place in the world of engineering in a way that I believe other students struggle to achieve, due to a lack of exposure to alternative career tracks and jobs within the field of engineering.

Monica, as with many other students, noted that UPri's faculty and administrative culture is very focused on teaching its students to make themselves marketable, most often through pursuing internships at competitive technology and business focused companies; in Monica's case, this was with Microsoft. She noted that her experience there taught her about the project manager position (in much of the tech industry this role would be called

product manager) where the manager drives the team, coordinates the work of interdisciplinary team members, and essentially manages a team's progress on product design and implementation. And she noted that, after years of also serving on multiple executive boards (e-boards) of student organizations similar to the National Society for Black Engineers (NSBE), her responsibilities were extremely similar to those of a project manager. Her demonstrated leadership was one of the other points about Monica's experience that characterized what an exceptional student she was. At one point during her junior year she was on three of these so called e-boards, and for one of these she held the role of Vice President, which she described as basically doing the job of the President, managing others, holding them accountable for their responsibilities, and making sure that they'd completed their board responsibilities by deadline. She noted that this was one of the things she realized she'd been able to learn and build as a competency while at UPri. But from her description, the characterization of her leadership sounded like she realized that this was actually one of her inherent qualities, that she began to notice made her different than those around her. She described moments of class group work or e-board work where she would look around at her peers and realize they had no conception of what they were doing or how to organize their actions to successfully manage their projects. By her junior year, she noted that managing was where she most naturally fit, at the helm of the group, because managing was something that she could do almost instinctively. And she had the chance to practice this by communicating with others and telling them what they needed to do and when they needed to do it, during course projects and student-group event planning and execution.

Monica is a Black woman, underrepresented in her field of study by gender and race, fully proficient and comfortable in her skills and the practice of engineering, but dispassionate about the meat of the work that an engineer carries out, i.e. programming and developing, but only partly aware that the additional skills she knew she possessed as

a wonderful communicator with a precise focus on how to best manage groups, were skills necessary to be a leader in the field of computer science and engineering. Product managers in the field of engineering are the employees in the industry that are slated to become the Chief Executive Officer or the Chief Operating Officer or Technical Lead, roles that confer a great degree of agency in decision making for the company as a whole. And from her perspective, engineering was ultimately not for her because she could not find the passion for it that she saw others had. Furthermore, this ran counter to her e-board experience. Serving on the executive board of upwards of three organizations one semester, as she was planning to hand those positions over the following year so that she could serve on two new boards, she explained that these positions were a necessity for her to continue in engineering. While the language that she uses to describe engineering does not intersect with the language used to describe product management, there's a clear overlap in the responsibilities and practices that a software engineer employs and a product manager employs. In fact in many engineering focused companies, product managers are trained in and receive the same degrees as their software engineer counterparts. Those working in each role are in fact practicing engineering on a daily basis, just in different ways, one of which seems to be more communication heavy.

The quote shared at the top of her story is deeply connected to her need to serve on the e-boards. In multiple interviews she described her idea of being an engineer as, someone that others view as serious, very focused on their studies, seldomly leaving lab to actually have a social life. It's interesting that the people she references, challenge her and question whether or not she is able to pull down competitive grades, and she has to tell them essentially, I am this cool, I am this communicative and personable, and at the same time I am intelligent enough to succeed in these very challenging classes. And others continuously distinguished her as different, and in some ways as being *down*. Self described as outgoing and talkative, she explained that she actually went out on the

weekends but could only note one other engineering student she'd befriended freshman year that would also go out with her. Monica noted that for the most part she did not go out with engineering friends because that is not what engineering is about, and those students did not actually go out. She nonetheless made a point to be social and involved and explained that there would be no other way she could get through the harrowing process of late nights of studying and working. She in essence, needed the social engagement or partying on the weekends, and organizing programming and events with her peers to remain sane through the challenges of being an engineering student. Monica noted that younger students would regularly ask her how she was able to do what she did, regularly achieving As, while also being so wholy involved in her department and having a social life.

From her first year to her Junior year, Monica complained about the inadequacy of her faculty advisors. From the first interview she noted that one of her peers had the frustrating experience of having followed an advisor's advice, and taken multiple classes that counted toward the same requirement. From speaking with her peers from the same class level that year she created a crowdsourced strategy of what courses to take to avoid this situation and the other common situation she noted of having missed a class requirement, which forced students to enroll at UPri for an additional year to complete requirements. While she emphasized the utility of leveraging classmates that first year to work as a group to create a curriculum plan, she went on in later years to note the value created from talking to upperclassmen that had already completed the courses she was enrolling in. She noted for her signals and systems class during Junior year that it was the only class she was not able to pull off an A in, as it was unreasonably difficult. She attributed that to the professor noting that while enrolled upperclassmen suggested she drop and re-enroll either during the summer session or at least at some time that, that particular professor was not teaching it. She employed this strategy for at least a handful

of classes as well, biding her time and knowing the best semester to take a class when the good professor was teaching it. And this was entirely due to the existence of the social network made up of senior and novice students. Without knowing how to leverage this social network, she would most likely have been at a loss for how to pass courses that she saw as being purposely designed to be unpassable, an experience shared by other students in this analysis as well.

Here she made a distinction between the types of professors she'd crossed paths with at UPri. At one end of the spectrum she'd had an amazing professor for Physics, who was dedicated to the point of meeting with students for regular review sessions at the late hour of 10pm, staying with them in the library until midnight to be sure that they understood the concepts he'd covered. For Monica this was the furthest end of the spectrum in which, a professor was so invested in making the material accessible and easily understood that he would spend his time on campus late into the night, as any other student. Here Monica made the distinction, noting that some professors mistakenly equated difficulty with learning. On the contrary she noted that the classes she'd learned the most from were the classes where the professor made the material the easiest, whereas the alternative professors believed that content needed to be overly challenging for students to internalize the concepts, as they struggled through the problems. In her experience this never proved to be successful. And this is where overtaxed professors, focused on research or focused on industry positions, ended up making the worst instructors of all. She explained that UPri made a mistake in thinking that an expert in their field of research automatically made a good instructor. On the contrary she found that professors well focused on research, made the worst teachers you could find. On top of this she noted that these professors were additionally overtaxed by the responsibility of advising students on what courses to take. She noted their ineptitude at suggesting the proper classes to take, and proposed that advisors should just be advisors, rather than also

having the added responsibility of research and teaching. She compared this to high school counselors having one job, and one job only.

Interest

Monica has been interested in what she calls the general area of technology and computers since she was a young child, and she chose the computer engineering major simply because it had the word *computer* in it. As we explore student interest in engineering, it's interesting to see where terms bleed into one another. The difference between the terms computer, engineering, and technology are subjective for students. It's possible that one can interpret the term engineering to solely mean computer engineering. In this case Monica seems to be interested in engineering to the extent that the term refers to working with computers and building software. She does not however, equate the practice of engineering with the career tracks that intersect with engineering, specifically product or project management, although she's been exposed to those roles during an internship at Microsoft. Monica equates the practice of engineering with the practice of programming, and she states that she has absolutely no interest in programming. She uses the example of one's frustration after writing 600 lines of code, only to find that code does not function in the way it is supposed to, due to one single typing mistake. While she expresses both interest and proficiency in managing and leading teams on class projects and on the executive board of multiple student organizations, she does not see a connection to an industry role like product manager or tech lead. In fact, Monica states that she engages in her roles on the executive board of these student organizations so that she can remain in her major. Without this communication, connection, and shared work, she could not see herself surviving on the track of engineering, but again she misses the fact that this process of managing and leading a team to execute on the design and implementation of a product, is in itself a form of engineering practice. In essence

Monica finds herself uninterested in engineering, but does not recognize that the practices that sustain her in the engineering department are the same practices that she could carry out as an engineer in the industry.

Identity

Within the scope of her interviews, Monica puts as much of an emphasis as she can on identifying as something other than an engineer. She notes that engineering students can be extremely isolated from the rest of the campus population, as there is so much that is required of them in their degree programs. Essentially, having to work day and night on assignments and in the lab in the basement of the engineering department seems very limiting to Monica, and she does not want to be *that* person, that engineer that is cut off from the rest of the world. She also equated engineers with being antisocial in general, not being able to hold a conversation, not being a good communicator, not shutting down work and responsibilities to have fun and go out. Therefore she stresses in her interviews multiple times, that people are always surprised to find out that she is an engineering student. Monica implies that people are surprised because she is in actuality, a very sociable person, she's portrayed by others as cool and as a outlier in the engineering department. She explains that people don't believe her when she says she's *engineering*. The next question they ask her is about her grades, she implies because they can't believe that someone so sociable and cool could actually have the time to fulfill all the requirements and complete all the assignments and work that engineering students are known to be bogged down by. These are the requirements that make engineering students unknown to the rest of campus, others never see them essentially. This is not what Monica wants to identify as, or be identified as by others. She expresses that her happiness in the program is dependent upon her having social contact with others, contact that is informal and just for fun, as well as contact that serves a purpose within

engineering on the executive boards of the student groups she runs, noting that it is this work that actually gets her through the stress and responsibilities of her degree program.

Attainment

Monica is proficient at math, she started programming in high school studying Cisco command language, seemed to be just a couple steps away from actually getting a certification for it, a challenging test that by her standards could have helped her earn a lot of money if she went into a work position, right out of high school. Monica is seemingly unphased by many of the technical and theoretical knowledge challenges that many students on her degree track seem to be stymied by. While she was not one to stress her proficiency in problem solving, her high grades as well as her ability to lead groups of other engineering students to complete work by deadline, something that could so easily be translated to industry, taken together make her appear as though she is a good problem solver. Monica seems to hold the qualities that many of the students in this analysis equate with being a good engineer. The student interpretations of these qualities seem to also equate with those students' references to what their professors think are the qualities of a good engineer. Monica seems to fit the high attainment picture very well, as she has the qualities that her community at UPri seem to deem the qualities of a good engineer. I would add that although she seems to not realize it herself, her communication and leadership qualities also make her well suited for the practical daily requirements of an engineer that is the technical lead for a team, or a product manager that leads an interdisciplinary team to design, implement, and release a product or feature.

Cost

Monica fervently dislikes the fact that engineering as a field of study, requires students to stay late in the lab many nights, losing sleep as well as any opportunity to be social and

spend time doing things that they might enjoy more than studying engineering. She balances a great deal while at school, her own studying and class requirements, as well as trying to maintain connections with her friends. It seems that the biggest cost for her in terms of being an engineering student is these responsibilities that she feels impact her having a balanced and fulfilled experience at UPri. Although Monica might not have an intrinsic interest in some facets of engineering practice as a student, i.e. putting a great deal of time into programming for a class, she does prioritize her performance in classes. Put another way, she is an academic performer and she knows very well what she has to do to perform well in a class and get a good grade. It seems that much of the challenge that she faces in her engineering courses is based on that, wanting to do well whether it is a topic of interest or not, wanting to get good grades. Because this is one of her major priorities, Monica also registers a great deal of cost in taking a class that she and other students have deemed as an unreasonably difficult class. She explains that some professors equate difficulty with learning and this is not something she believes in for a second. In fact some of the engineering classes that she has learned the most in have also been the easiest, where her professor has worked to make the material easily accessible to students. So when she finds a class to be unreasonably difficult, she feels some degree of remorse for having fallen into the trap of taking that course, which she and other students in this analysis describe as a course with the wrong professor. This would be a course that she alternatively should have waited for summer term or a different semester to take, when the professor that was reasonable was teaching it. So courses like this that she has to take, or somehow accidentally gets stuck with, also create cost for her.

Utility

There was a transition that happened for Monica over the course of her time at UPri. Once she reached junior year and hit upper division electives, she came to a pretty clear

conclusion that she had very little passion for the field of engineering, but she also wanted to continue with the program as she had come so far and wanted to see the degree through to completion. I trust that some level of academic performance was also important to her, as it had been up until this point. In essence she wanted to get good grades and find success in her studies, and she believed that successful completion of the program would still ultimately lead her to some career that she might find greater fulfillment in. And this was the utility, the usefulness or practicality of completing the engineering degree, that she could prove herself as proficient in her studies, getting good grades completing her extracurriculars and being able to translate that into a job role that she'd not yet identified. She completed her degree, and I can only hope that she found a role similar to product manager, or technology lead that allowed her to leverage the many skills she spoke of in her interviews.

Sanaa

Sanaa is a student from Trinidad studying Systems Computer Science, that feels limited by her international student status, due to the fact that she has less access to jobs than U.S. citizens, and feels that she has little opportunity to express her political feelings through protest, as the smallest of incidents might lead to her being deported, and losing all the past work and effort that she's put into completing her degree.

Sanaa's identity as an international student is very intriguing as her perception of it seems to be focused on the ways in which it can be very limiting. As Sanaa is an international student she is not afforded many of the opportunities that her classmates are, such as access to full time jobs after graduation: "But for the most part like some career opportunities you can't take advantage of because they're not hiring international

students um you can't do certain things because you're international, you could find yourself deported, um. And I mean after you've taken your time invested your energy, whatever to come and some foolishness happens and you end up back home, still without a degree yeah [laughs]." When she first entered the university Sanaa was told at an advisory panel session that she basically had no real rights there at the university. Something could go wrong and she could get deported and lose the chance to get her degree. She notes that she also does not have the right to protest alongside her colleagues and classmates, so she explains that she has to avoid these types of events at all costs, and limit the expression of her beliefs whether she wants to be involved in protests and strikes or does not. "And um, I remember when [we] first came, like, they had an international students information-y thing or whatever. And the lady was like, "You all have no rights, like if something happens, catches [up with you at] something that's it, you've-, you might not've even been the one who broke the law, whatever but you've just ended up on the wrong side of it, you're back home." So it's like you can't even protest anything, you can't get involved like if, um like let's say if some-, like I-, when I was [um, going up on] campus, then somebody was striking. I can't be seen anywhere near that. I can't be in any way involved. If the police comes when I'm there, that's it. So it's like if something happens at school, where you know you feel so strongly about it like, you have to go and protest you do not [laughs] essentially."

When it comes to the engineering department and her experience with course work, Sanaa begins her first interview by describing how challenging the third semester of college was for her, so challenging in fact, that the semester makes up a substantial part of her fourth year interview as well. In her very first APS interview, Sanaa explains that her third semester was her hardest yet. Having to transition back from break to enter a new semester caused a lot of the struggle, having to ramp her energy back up to deal with what would turn out to be a very heavy course load. That semester she was taking five

classes, which included Physics with Calculus III, and Calculus II. The effort that went into building her energy for studying back up, coupled with the extended period of time between this semester's Calculus II class and the Calculus I class she'd completed during the prior academic year, caused her to struggle a great deal. "Somehow, I don't know, like that was like a kick in the butt for me but in the end I turned it around and I, somehow I came out with A's except for the one class I couldn't swing… Cal II I got a C." Additionally, she references having taken a pre-calculus course while at UPri, which a number of competitive universities actually do not offer their pre-STEM track students, as they expect their students to have completed this level of math prior to entering college. This evidence also supports why Sanaa might have struggled with the Cal II course at this point. The fact that she was taking this more introductory course this late in her academic trajectory, is a testament to the amount of effort she ultimately put into her practice of math and engineering during this third semester at UPri. Sanaa continuously references the challenges she faced while trying to recall content from earlier courses in math, and the overlapping material between physics and calculus that required her to recall so much of the content earlier in both class series. This overlapping content would ultimately help her find success in Calculus III, as although the content in Calculus II caused her stress, she was able to apply a great deal of what she learned while struggling, to the last class in the series. Some of the struggle of this third semester also appears to be due to the challenges associated with transitioning from being a first year to a second year student. For example Sanaa speaks at length about the mistake she made by delaying her purchase of the required textbooks for the semester. What appears to be a common process that many students go through as they transition to college life, Sanaa noted how much stress not being prepared with the proper books caused her, and how much hustling she'd had to employ to borrow books from others, and ask her peers for help with homework assignments. Sanaa talks about pulling an all-nighter before a test, a practice that resulted in her feeling as though she were drunk the following day during the test.

This was noticeable even to her peers, prompting them to approach her and ask if she was alright. “I can’t not sleep, like stay up go to class directly, haven’t slept since the night before, the morning before actually I’m not doing that ever again. I really, it has to be really serious but I have to get sleep before I try to do anything productively. I have to sleep..." But I’m to doing the not sleeping thing hm-mm. That’s the kind of thing that destroys you [laughs]. And you’re not taking care of yourself."

As Sanaa talks about some of her struggles during her third semester she also notes having to call home a lot to get social support. “Last semester was, it was -- I don’t even want to talk about it anymore… I called home and my sister said she’d pay for me when I told her how despairing I was”, in reference to paying for her travel home for some respite. Sanaa sounds as though the weight of the requirements in each of her courses was a lot for her to have to carry. “I don’t, I don’t get depressed but you know I, I and I looked at it objectively and I was like, “If somehow these teachers would take a liking to me… or something doesn’t improve y’all won’t be seeing me next year, you know like that’s it, I, I’m done." She notes despair, a want or a need for some support or approval from her teachers, and the possibility of dropping out due to the pressure of needing to perform well in her classes. Sanaa goes on to note her need to find extra credit just to be able to pass her courses. In fact she explains that she does not understand how she ultimately ended up with an A grade in Physics. Again, as she emphasized that her third semester was so integral to her experience at school when it came to struggling academically, she also described it during her fourth year interview, explaining that she did not perform well on her first two exams that third semester, scoring percentages below twenty on each, and ultimately achieving a 77% on her final test for the course. So how was she able to overcome the challenge of her third semester? Sanaa notes leveraging her peers, getting them to explain homework problems to her, so that she could achieve the maximum number of points possible for each assignment. She notes

attending class sessions that very few of her classmates ended up attending. In these sessions she found that the professor ended up giving extra unplanned quizzes that also gave her the opportunity to score what she called "bonus" points. Sanaa's best assessment of her circumstances that semester was that her professors must have found a way to give her extra chances to achieve a higher score, because she notes that based on her test performance, there is absolutely no way she could have achieved A's without some additional opportunity to display her knowledge of the content. Interestingly, Sanaa gives us multiple examples of introductory-STEM course professors giving her ample opportunity to succeed by performing well on supplemental assignments, some of which were also dependent on her regular attendance in class. This is very different than the more common anecdotal descriptions one hears of introductory or gatekeeper classes at other institutions, where faculty and students describe a process of weeding out those students that are not viewed by others as suited to go into STEM careers. And from my analysis of many of the other student's experiences here at UPri I'd surmise that this has much more to do with these particular professors investing in the success of their students in the engineering department, as with the earlier example that Monica shared. Her professor was invested enough in his student's success that he held sessions from 10pm to midnight in the library, to be sure his students were well prepared for their upcoming exams.

Sanaa, as many other students from UPri, notes participating in an internship at Microsoft. Interestingly, she shares the example of the lifestyle choices of a full time employee there, and how those choices relate to the topic of identity. Specifically Sanaa sees the opportunity to have a certain type of family-focused lifestyle while working at Microsoft. The employee she describes spent a great deal of family time with her mother, although she also had her own family and children. Sanaa explained that the employee had planned to leave the Microsoft campus at the same time the interns were completing

their internships, so that she could go on a vacation to Europe with her mother. Sanaa was impressed and inspired by the fact that someone at the company could still take their mother on vacation while they had a full time job and responsibilities to their own immediate family members. “That was really cool too, it was like, “wow, you still go and do stuff with your mom”, you know. Cause she has her own family and everything… just taking your mom to Italy, I was like “wow, I want to do that someday! [laughs] you know?” At this point Sanaa is seeing that the career roles that she’s working to identify with or see herself pursuing, can actually be aligned with some of the life choices or lifestyles that are part of her current life and culture, like being in contact with, and sharing time with one’s family.

At a later point in the interview, we’re given further evidence of the outside parties’ input on defining one’s identity when the interviewer brings this point back up to get further clarification. The interviewer states, “You mentioned earlier that you, um, have taken an English class and where you computer science majors all got A’s, and you’re not supposed to typically. Those were your words.” Sanaa states “Na, that was his words. [laughter]” in reference either to the other student in Sanaa’s group or to the professor of the course. To further expound on the ways in which parties apart from the individual influence and define her identity, we find that Sanaa makes the point that, for any course of study— engineering or non-engineering—as one moves forward to higher division courses, she then concentrates more on her major and the courses within her major rather then courses outside of the school of her major. “I don’t know if it’s the same no matter what major you are, that as you go higher up you concentrate more in your major like. You do like... higher courses, you don’t really do courses with other schools and that kind of thing.” Sanaa feels that this process for engineering adds to the isolation of its students at UPri. “And I think, because I thought we were kind of isolated before like, people have this image, like I’ve actually spoken with people who are not engineers, and they’d be

like, they feel uncomfortable being in the engineering building. They always feel like they don't belong there." Sanaa goes on to describe a female, non engineering student (Sara) that always feels uncomfortable coming to the engineering building, noting the glass walls and feeling as though people are looking at her. Sanaa's colleague is worried about what she looks like when she frequents the building and that it's not what an engineer looks like. Sanaa believes that Sara feels the way she does because Sara is female and being looked at by male students, but Sanaa notes that her colleague believes it is due to the fact that she herself does not actually belong there because she is not an engineering student. During Sanaa's description of her conversation with Sara, this distinction is explored further as Sara references Sanaa's areas of study and her intelligence, to make statements that seem to push on Sanaa's own understanding of her identity, as well as Sara's understanding of Sanaa's identity, especially how that identity is tied to Sanaa's interest in specific areas of the engineering curriculum.

> You know, she just does not feel comfortable in the engineering building. And she always tells me, it's like, "And you guys are so smart and," she is like, it's like she has an inferiority complex dealing with engineering people [laughs] cause she's like… "You have to do Cal III and you have to do this," and she's like, "Please, I don't want to hear anything else about math," because they always have [this thing in engineering], you're good at math, you like math. It's like your thing. And people [hate] math. And I'm like, "We're not any different." I know some people who really do like math, but we're not any different, it's like math is not really my thing.

Sara notes here that she perceives engineering students as more intelligent, and complains about having to talk about math with Sanaa, making the assumption that Sanaa is not only experienced at math, but also greatly enjoys the subject. Sanaa seems to wrestle with this

external definition of her identity by another. Her colleague assumes that math is Sanaa's "thing", but Sanaa disagrees with this assessment, clearly having stronger interests in other areas. In fact she characterizes her experience with math in such a way that her practicing math seems to fit with the motivational value codes of *utility* and *cost,* in that she recognizes that to some extent she has to sacrifice part of her life to do well in the subject, because her successful completion of a degree in engineering is so reliant upon the work she puts into studying math. "I used to like math before, but I hadn't done it in awhile. And then I came back to it and it was like, "Whoa! You have to bite the bullet and do it."So even if I don't like it, I might be getting A's and you're like, "Oh, but you're really good at it." You know [I] have to get it so I can get my degree, you know so you do it." Additionally the description of this exchange further showcases Sanaa's understanding of her own identity. Sanaa does not see herself as "smart" per se, but she recognizes that people outside of her department clearly view her that way.

> And she's looking at it like, "Oh my god, you people are so smart. "So I was like, "But I don't think I'm that smart." And that's the.. perception she has of me. And I'm not looking at myself and thinking, well, "Ooh, I'm the greatest thing that ever walked. I'm a genius." I don't look at myself like that, and yet she will come to me and be like, "Wow, I can't believe you have to learn all this….

Sanaa's characterization of her level of confidence aligns with additional statements she shares near the end of her first interview, when the interviewer has her carry out an engineering exercise, asking her afterward "did you feel confident in your ability to complete this task?." Sanaa states,

> Okay like-, I , I don't ever go into anything expecting to have the answer. So I'll go in like from below and be like, "Okay, I may not get this, but that's okay," you

> know so like I always [laughs] it's like a little pep talk, it's like, "Even if you don't get it, you're not really stupid, you just don't know." You know, so I always go in saying, "It's okay if I don't know, if I get it then that's good," you know. So then when I read it it was like, "Okay, I think I could do this," you know, and then I [worked on it].

Here we gain insight into her feelings about her identity as they relate to her intelligence and her ability. Her internal dialogue shows her moving up and down in her level of self confidence, and her ability to modify her interpretation of the situation, as she reflects on her own performance. She essentially talks herself down from a moment in which she is questioning her own abilities. Sanaa goes further to make the distinction between how non-engineering majors describe engineering major's identities, and how engineering majors often perceive themselves instead as people that go unnoticed or forgotten in the school.

> I mean that was just her, but most of the people I know are engineers, you know. So you find like, all of us might have the same, oh at least similar ideas about it but we don't really talk about it. So normally you hear what people who are not in engineering think about engineers you know, and oh but engineers themselves think like we're forgotten, are forgotten [in the] school like [laughs].

Sanaa goes on to exemplify these points with a story about waiting for a night escort home from the engineering department after hours. The campus buildings in which the department are housed are called both the architecture and the engineering buildings, but while Sanaa and the friend she was waiting with that night understood which of the two buildings was considered engineering, the campus escort was an outsider to the department and went to the architecture building instead. After waiting an extended

period of time, the two waiting students called the safety number again and were ultimately unsuccessful at describing which building they were waiting in, because they as a part of the engineering community, knew the building as *engineering* but their escort did not. The two students therefore ultimately had to go to a completely separate building that was more easily identifiable by outsiders to engineering, to get picked up by the campus escort, proving to Sanaa and her friend, how out of touch others outside of engineering were with their department, and further reinforcing Sanaa's beliefs about how engineers are perceived. "So, I, I don't know about the perception but it seems as though everybody is looking at it like we are not like regular people [laughs] you know."

Sanaa's identity is further defined by her abilities in a non-engineering field, English and writing. This is significant because while she is defined by classmates as an engineer focused on mathematics, she finds that in this humanities class she's able to showcase her writing skills and surprise those around her that have accepted the stereotype that engineers are not experienced or talented when it comes to writing. Sanaa begins by describing how her advisor pushed her to take english courses in her first years at UPri. She describes her advisor encouraging her to take courses that she was suited for, "because he knew I was more a language person." In one particular English class, Sanaa and three other engineering majors were stereotyped by both the teacher and her classmates as being solely science focused, and therefore not proficient at English. "So like this one guy in our group, he looked at us and he's like, "This is just wrong! This, this can't be right." People, science people we, by just reputation, not supposed to be that good at English, and it was like, "Well, whatcha gonna do? Suddenly not be good at English?" In this case Sanaa and her classmates were being typecast as solely engineering focused people, and therefore only good at math. Sanaa and her engineering major classmates challenged this stereotype by doing very well in the course and on the assignments, performing to the extent that Sanaa even surprised herself. " I think we were

only four or five people who got 50's in the class and so like, okay! Who knew?! I was in shock too because I thought I had screwed up on it."

This expression of identity defined by self and by others clearly overlaps with Matusovich et al.'s operationalized definitions of the Eccles' *attainment* value, "a reason for pursuing (or not pursuing) engineering that is related to being the type of person who is an engineer" (Matusovich et al., 2010, p. 294). What's interesting here is that the operationalization of the construct of attainment is dependent both on a reason that is related to being the type of person an engineer is, as well as related to being the type of person that an engineer is *not*. Earlier in Monica's case for example, engineers were not sociable, not cool, not fun to be around, they weren't talkers, communicators, people that could put you at ease or people that you could go out with and have fun with. Now in this case for Sanaa, her own perceptions of her identity as well as the perceptions of those around her, are that engineers are not masters of other areas of expertise like writing. This fits into Monica's earlier theme of sociable communicators, as it seems that in these two students' understandings, those around them are flummoxed by their adept ability to communicate in different forums. For Monica, it's communicating, organizing and managing student lead groups and campus organizations. For Sanaa, it's her abilities as a writer. But Sanaa challenges this socially defined identity where engineers are perceived as bad writers and poor performers in humanities classes, by outperforming the majority of her classmates. Matusovich et al. provide an example for their operationalization of attainment, "I am a problem-solver and engineers are problem-solvers" (Matusovich et al., 2010, p. 294). Applied to Sanaa's experience, what does it mean to Sanaa when she hears other people's interpretations of her identity that actually oppose her personal value of attainment? In this instance we have an example of a social group within the university, Sanaa's classmates, but also other students that she comes in contact with, as well as her teacher, stating outright, "engineers are not normally good writers." Sanaa

clearly identifies herself as a good writer when she states, " I was more a language person", and shares that she scored higher on assignments than the rest of the class. In this case an alternative attainment value is presented. Sanaa can state "I am a good writer and English majors or other humanities majors are good writers", therefore she's aligned with attaining an education or a career in the humanities. The question is, how diametrically opposed are her and other students' perceptions of engineering vs. the humanities? Does identifying as good at something in the humanities, and having a high attainment value for writing and English, oppose her attainment of a course of study and a career that is more focused on science and math, as engineering attainment might be? Clearly it would be easy to state that these students have an array of targets for attainment and a spectrum of identities. My worry here however is that these identities and targets for attainment are so opposed to one another in the culture of the university or in the field of engineering that a mixture of identities and attainment values create friction. Attainment values and identity values that oppose one another, might cause students to leverage and focus on the skills and identities that come the easiest, drawing them ultimately to the fields that they begin to see they are most "suited" for, based on identity and attainment, rather than pursuing the fields that might be called a stretch for them, as in fields that they might have to struggle with or work harder to find success in. It would be very easy for Sanaa to gravitate toward a degree in the humanities, where her writing takes very little effort and she is quickly rewarded for her performance. Compare this to her struggles with calculus and physics in her third semester, when she notes "something doesn't improve y'all won't be seeing me next year, you know like that's it, I, I'm done." It would be very easy for a student to continue down the path of what they know best, what they are already good at, rather than pursuing the courses or the degrees that prove to be difficult. Sanaa's remaining in her major into her fourth year is a testament to the challenges that are showcased through these aspects of her identity, the way she defines it and others define it, as well as her attainment, the way she can easily equate herself with

the qualities of an English major, versus the struggles she faces getting through Physics with Calculus and Calculus, and not knowing how or why she was ultimately able to pass. This idea of taking the opportunity to stretch beyond your comfort zone or your skill set, seems less significant than an alternative scenario. What about the students with multiple identity and attainment values that don't need to struggle or stretch at all toward an engineering path? What if in these cases it is the identity and attainment values that are largely defined for them by the institutions and the groups around them? Much of the way that these values are defined by and for students, is largely dependent upon the culture of the institutions around them, and the culture of their family and friend groups. How much of a challenge or struggle is going on internally for students that have opposing identity values, as well as opposing attainment values? Ultimately how might educational institutions, the designers of the curriculum and culture of these institutions, recognize the existence of opposing values and make them more visible to our students so that they can reflect on their own experience, and work on making the decisions that are best for their educational experience and future careers?

These points about identity and attainment lend themselves to the fluidity of a student's pursuit of a particular career track. There are challenges faced on the engineering track, and easier paths to follow that they might have more experience with, that can pull a student away from an engineering career. So students sit in this fluid space in college and choose from the tracks that are easy or difficult, interesting or uninteresting to them. In this case Sanaa describes ultimately wanting a career in "web work, web design" and lays out entrepreneurial aspirations as well. She talks about the possibility of returning home to Trinidad to create a platform similar to Monster Track to source computer focused jobs. "And I was thinking about setting up a network like that back home, of course it wouldn't be Monster Track but you know based on that kind of basic idea, and I mean it's gonna be a different culture." She goes on to talk about also providing computers and

internet access at internet cafes as another possible business venture in Trinidad. It's the fluidity of possible career tracks that stands out here, and it's best showcased as she describes how she went about pursuing internships (one at Microsoft and one at Goldman Sachs). As Sanaa weighed which internship to pursue, she found that she was most interested in diversifying her experience, but wrestled with how this might be perceived by each company's recruiters. Ultimately Sanaa worried that she might appear indecisive, or appear as though she does not know what she truly wants or what she is most passionate about. In this, she also had worries about burning bridges that she might otherwise have been able to access for future jobs after graduation. The way she characterizes her analysis of the situation is representative of the mindset that I assume many students have as they explore, both their fields of study and the prospective jobs and careers that might result from them. "I don't know what I want because I don't know what you have." This statement is powerful because it so succinctly describes the understanding of a novice or an undergraduate student in any field. This means that Matusovich et al.'s *cost* code is expanded beyond just the cost of pursuing an engineering career, to then also include the cost associated with being an engineering student. Again, Sanaa's not knowing what she wants because she does not know what the corporation has to offer her in terms of positions and work-life balance, can also be applied to the Matusovich et al.'s value code for interest. How can we define a student's interest in the field of engineering when they are in the phase of being novices, and have had so little exposure to what a career in computer science or other fields of engineering is actually like.

Sanna notes that companies told her as an international student that they don't care how good she is at her craft, they don't want to have to deal with the challenges that visa students bring, so there's no chance of her getting a job from them. "Job-wise, uh, certain companies don't want to go through the hassle, that's the bottom line. They don't want to

have to deal with it and they just say well, they come in and they say point-blank, “I don’t care how good you are. Forget it. I’m not going to hire you. I’m not even going to look into it.” Because they don’t want to have to deal with it.” When asked about differences in student experience on campus due to gender, Sanaa is very pointed as she emphasizes the limitations of being an international student are more outwardly expressed. The interviewer asks, “so what about because you’re a female? Is it different for that?. Sanaa states, “they would not ever come out with that, but for the most part, they actually stipulate across the board, “International, forget it.”” When it comes to gender, Sanaa describes one of her observations as a “personal thing." She notes that there are not enough “ladies” rooms located in the engineering building. She explains that she does a great deal of work in the basement and has to go to the second floor to find a bathroom, whereas other buildings have two to three restrooms available for women.

But Sanaa actually sees no difference in how she is handled by prospective employers when it comes to her gender. On the contrary, Sanaa actually sees being a female and black as a twofold advantage because a company that would accept a black woman is essentially checking off two boxes for their quotas. Sanaa describes this by using an example of a conversation she had with a male student where the two focused on their applications for a particular job. Sanaa told this male student that she herself felt well qualified for the job, but also emphasized his qualifications as well.

> "Okay. Well. Actually, being female and black is an advantage because people are looking to bring up their quota of black people and, well minorities and um females and whatever… so that’s kind of unfair to the guys, but I’ve seen it. And even though I’m like, “Oh, I was good.” “Well, you were good too.” … You notice like [if it] went the other way like… but it was like he’s at a disadvantage and I have like that upper-hand. So in that sense I’m seeing a kind of

> discrimination, not against me but against the other person. And they're looking at it as I have one person and I've just taken care of two issues, whereas here it would just have been one issue, you know so you do see it, you know."

Sanaa shows a clear transition in her thinking between her first and second years at UPri. She describes that when she entered the university, she planned to attend every class session religiously, but soon found that even with this level of dedication, she was not performing well in her classes. "He was doing the lesson and I'm just copying notes like nothing is sinking in." As she transitions to her second year, she finds herself continuing to attend most class sessions, but does not hold to this practice as stringently. Sanaa shows signs of learning that success for her is not about attending each and every class but instead about finding ways to own her studying process and hold herself accountable for it. Sanaa found that even in a very fast paced course, her understanding and retention of the material is better facilitated when a particular professor makes a point to regularly stop at branch points in his lectures, to show examples of the concepts that he's covered and solicit answers from the students in the class session. This for Sanaa was an example of the great extent to which her learning takes place in between sections of content, and even in between class sessions themselves when she is at home, concepts begin to sink in and become more clear.

> "He would try to break it up by giving us an example and say, "well, okay, we just did something, so let me see if you understood… and he'll go to the next slide and say, "okay this is an example. What do you--, which one do you all think is the answer?... But I don't know what to vote fro because I don't understand. Then he'll make sure and explain it because of that. Then I understand what went before. You see if I go home and I look a it I eventually pick it up."

It's these small chances, these brief moments and tidbits of information that seem to end up making all the difference for Sanaa. She explains a revelatory moment when she came to the first question of an exam that referenced the usage of resistors. In this moment she realized that she'd only studied the qualities and characteristics of capacitors, and knew nothing about resistors. She describes panicking and feeling stuck in this moment, but then quickly remembered one comment made by her instructor about resistors having the opposite qualities of capacitors. Being present at that lab to hear that single comment meant the difference between her success and failure as she immediately knew to run through the problem, treating it in the exactly opposite manner she would had the problem been about capacitors, ultimately answering the question correctly. Sanaa references the idea that she need not act with such stringence by attending each and every class meeting, but instead realize that it's an accumulation of tidbits, like capacitors being opposite in nature to resistors, that ultimately lead her to success. Here Sanaa has learned how to modify both her interpretation of the structure of school, as well as her study practices to increase her chances of success.

And this family support and family interaction also shows the overlapping values of cost and identity. Sanaa found that she actually needed to call home just to get moral support, and found that her 10 years younger sister encouraged her and told her that she believed that Sanaa would make it through this tough time. Sanaa realized that her family believed in her and had faith in her ability, so Sanaa therefore also settled on believing that she was capable of completing her requirements. " So I have to call home to get pepped up [laughs] so I like telling them "I really don't think I'm gonna make it!" Sanaa's younger sister tells her very simply "you'll be alright!" Sanaa explains in the interview "okay, I'm gonna hold on to that. And I think after that… you know it was like, "You know what? They have faith in me that I can do this,." Talking to her family, Sanaa's cousin was amazed that she was pulling down upwards of 18 units a semester. Sanaa explains during

her interview that this was what the degree, essentially required a student to do, to complete course work in four years to graduate. “My cousin didn’t understand how I was doing 15 and 18 in the first place but [laughs]... she didn't understand how I could be in engineering doing 15 and stuff. But that’s what the curriculum asks for and you have to get everything done in four years." Sanaa shared more descriptions of how hard that third semester was in particular, also pointing out that it was not just hard for her alone. She found that all the students around her were discouraged as well. For this reason Sanaa was unable to find support, or find a way to recharge while she interacted with her classmates because they were also experiencing the same levels of apathy. “I was like, I kind of got like this apathy, especially last semester it was like, “Ugh!” like I said it was really hard. And everybody I talked to was so discouraging because they were all discouraged too. So you couldn’t get pepped up by anybody because you were all in the same boat.” The cost of being an engineering student here, and ultimately pursuing a career in engineering is that students have to take on challenging course loads, challenging due to the number of units taken, as well as the challenging nature of the coursework itself. But these moments are evidence that as Sanaa sacrifices her time and effort, she also recognizes growth in her identity. She is in effect, one of *those* engineering students (defined by those outside of the engineering department) that is willing to sacrifice her emotional and physical resources to take on a large course load, made up of challenging classes, be inducted into an honors society earlier than all her other colleagues, and organize her fellow classmates in student groups by leveraging time management skills she’s essentially learning on the job, the job of being an engineering student at UPri.

Even as she references her challenging third semester (over the course of multiple interviews), she still recognizes her own growing confidence and the depth and scope of her learning. “I feel much more comfortable this semester I feel like, you know I, I could

do it. And I think that frame of mind is helping me to accept the burens I'm dealing with like I have a quiz for Cal III on Monday and I have a test next week and yet I feel as though, "okay, it's a hard topic but once I understand the basics, I think I could [inaudible] and pass the test, "you know." Some of this growth is additionally growth in her perception of her own identity. Sanaa describes her reasons for being involved in student organizations as a practice that encourages her, but also an extracurricular activity that teaches her a great deal. As she is tasked with organizing everything for her classmates and colleagues, she feels that she's been given an invaluable skill, time management. Sanaa explains that back home in Trinidad she was far from being seen as organized. "Like the fact that I'm trying to organize everything, keep on top of everything I think that's an invaluable skill because that's like time management. And that was something I was not known for back home. I could organize my [room] down to a tee, but my time would be lost [laughs] you know." Clearly some of this growth in identity is also growth in her confidence and a recognition of how capable she has become over the course of her learning transition from high school to college. Sanaa was inducted to Upsilon Phi Epsilon, an honors student organization, as a sophomore, but soon found that inductees were actually required to be juniors or seniors before induction. "They had invited me to joint that, um that second semester. I'm actually not supposed to be there because I was a freshman and I found out after I was in the org like, I was, I think last semester that when they were inducting people they were only supposed to induct juniors and seniors, so I was like, "So I'm a sophomore telling these people that only juniors and seniors are supposed to be here, and I'm a sophomore."

We also begin to see the overlap between the values of interest and attainment in Sanaa's educational pathway. To some degree, Sanaa has a level of expertise and confidence about what she knows, what qualities of an employer or a work environment she needs, and what facets of her engineering career are most important to her. In this sense,

knowing what is important for her when it comes to an engineering role in a company, is a form of attainment. Matusovich et al., 2010 reference the idea of a student seeing himself as a problem solver, engineers are problem solvers, and this demonstrates a facet of attainment for students on engineering paths. When we apply this attainment value to Sanaa, we see that in addition to liking the product that a company makes, Sanaa emphasizes the importance of employee communication with one another within the companies that she's exploring for future employment. "Yeah, I can investigate so much, and I'll know generally that I like your company. But that's all I know, I don't know how you move inside it, how the people interact with each other. And I'll know when I get there." When we compare Sanaa's case to Matusovich's operationalization of attainment, we notice that Sanaa already sees herself with confidence as an engineer to the extent that she can crisply envision what work or career role she will take on in engineering after graduation. She's selective in what internships and future full time roles she pursues and therefore plainly sees herself as an engineer. "I'll know *when* I get there" and "I don't know how you move inside" are very selective statements. Getting to the company and working as an engineer seem to be guaranteed to Sanaa, she's gotten to the point of vetting the companies to see if they have what she wants rather than the reverse. This is very clearly an attainment value.

Interest

Based on the data that Sanaa shares during her interviews one could think that she does not really have a very deep interest in engineering. One would have to assume that she is not interested in her field, as there are very few points at which she expresses that it is interesting. She actually notes that she has no real genuine interest in math when her friend projects an affinity for math on Sanaa. Rather than talk about what she likes about engineering, she instead talks about assumptions that her friend makes about her interest,

explaining the ways in which her friend's assumptions are actually inaccurate. Sanaa's friend Sara complains about Sanaa talking about math, to the extent that Sara expresses that she doesn't want to hear anymore about math from Sanaa. Sanaa explains to the interviewer that this was just an assumption that Sara was making and describes math to the effect that it's not really even her thing. Sanaa actually struggles a great deal with math in her courses and does not refer to enjoying it or liking it.

Identity

Sanaa's identity has a lot to do with her being an international student, as she is not afforded the same opportunities that citizens of the U.S. are when it comes to job and expression of her beliefs. Sanaa at one point recognizes a Microsoft employee during her internship that is very dedicated to her extended family, the employee's mother specifically. In addition to having a family of her own, this employee planned to take her mother on vacation to Italy and Sanaa related to this employee. Sanaa seemed to have a revelatory moment in which she was amazed that there was someone within the field of engineering that was dedicated to their extended family (we may assume as dedicated as Sanaa was to her own family) that could successfully practice their job as an engineer while still having enough time to spend on connecting with and sharing a trip with her mother. This ability to identify as an engineer that still had time for caring for family, seemed to be a big part of Sanaa wrestling with seeing herself as a future engineer. This idea also bleeds into the value of attainment, which I'll speak about shortly. In this case, Sanaa is seeing that it's possible to say, engineers can do their jobs and take care of their loved ones, I care for my loved ones as well, and that is a part of what is possible as an engineer. It's a bit more of an indirect interpretation of attainment, as we're not saying that caring for your family is a requirement to be a good engineer, but we are saying that being an engineer and being able to care for family is possible, which I believe put Sanaa

a few steps closer to believing that she was suited to reach her end goal of being an engineer.

Another important moment that relates to identity for Sanaa, has already been referenced but it's important to return to it in this category. That moment was when Sanaa's friend Sara talked to Sanaa about constantly feeling uncomfortable whenever she would visit the engineering building. Sara explained to Sanaa that she felt like engineering students were looking at her as though she did not belong there. Sara also seemed to feel that Sanaa was much smarter when it came to math and sciences than Sara was. This again is a brief nod to attainment, as Sanaa in this instance has a friend that is identifying her as good at one of the attributes that Sanaa believes makes a good engineer. But also important is the idea that Sara makes a couple assumptions here that do not jibe with Sanaa. Sara expresses her assumption that Sanaa is extremely good at math. Firstly Sanaa does not feel that way about her own identity, whether Sara is projecting that identity on her or not. Sanaa notes the many places that she has had to struggle and work hard in her math courses. Sara also expresses to Sanaa that she believes that Sanaa is to some extent obsessed, so much so that Sara actually complains that she does not want to hear anything more about math and what engineers practice while she talks to Sanaa. Sanaa does not relate to the identity that Sara is placing on her. Sanaa actually does not see herself as extremely smart or extremely proficient and successful in math or in engineering, for that matter. This is a moment in which Sanaa is having someone else project their perspective of Sanaa's identity on her, and she is unhappy with that. But the establishment of a student's identity is two-fold, the individual's definition of their identity, and how they are identified by others in their personal, work, and school lives. This brings us back to Stevens et al.'s description of identification as a "process of positioning ourselves and being positioned by others" (Stevens et al., 2008, p. 357). This is an instance in which Sanaa is wrestling with her own identification of herself and her friend's identification of her.

The next example of the identity value comes up around Sanaa's interaction when she and another friend request a night-service escort to walk them back to their dorm from the engineering building after dark. This example speaks to one of the ways in which the identity of engineering students is one of isolation and separation. While Sanaa notes that engineering students like herself are perceived by others as isolated from other departments, we find that this isolated identity is further reinforced by the original design of the school. Due to both the layout of the campus, as well as the limited knowledge of non-engineering students about the department, no one outside of engineering including the night service escort could identify their location on campus. This is a telling example of what seems to be an identity that is partly self imposed by the normal everyday practices of engineering students, as they isolate themselves in the basement of the department to do lab work, as well as an identity that is partially externally imposed by others outside the department, who do not know much about what is going on in the department itself, so that people do not know, or are not curious as to what it is that is actually going on there. And lastly, in a similar instance, Sanaa's identity is further reinforced by students that for the most part seem to be humanities majors, when her classmates and English teacher are surprised that she and her two other engineering classmates actually end up scoring among the highest grades in the course. Here the teacher and students expect Sanaa and her engineering classmates to be poor writers, and of course much better at mathematics and all things engineering.

Attainment

Sanaa struggles a great deal with her courses during her third semester, doing poorly on tests, but she put in as much time as was possible to do extra assignments and show up to class sessions with low attendance, to learn as much as possible and show her dedication to the courses. This particular semester she ultimately did not know how she was able to

pass these courses, in some cases achieving very high grades. Sanaa actually took precalculus in college, at a later stage than many of the other students in the analysis, and therefore faced a number of struggles with the math courses that followed, most likely because she'd had less time practicing a higher level of mathematics than some of her other classmates. Sanaa consistently referenced the problems that she faced in having to recall math concepts from earlier courses in a sequence, or in overlapping content courses like calculus and physics. In fact, even as Sanaa worked to solve an engineering problem during one of her APS interviews, she thought aloud and explained that her knee jerk reaction to solving problems like this was to jump to the conclusion that she would ultimately be unable to find the solution. Sanaa finds that she constantly has to give herself a pep talk to convince herself to relax and feel assured that she will eventually find the best path forward. Sanaa shared that she has to constantly work to convince herself that she is capable of solving problems. Sanaa also notes that she has to do a lot of work to get herself to accept the fact that it is justified and valid when she does not know the answer. It is this lack of confidence I believe, that hampers Sanaa's level of attainment when it comes to her seeing herself as possessing the skills that an engineer must possess, and therefore having the potential or the capacity to ultimately become an engineer. And actually, she also recognizes that she holds qualities that are instead equated with what an engineer is *not*, like good writing skills. When Sanaa looks at the qualities that make a good engineer and realizes that she does not necessarily have those, i.e. is not necessarily good at solving problems or doing math, she also realizes that she therefore might not feel assured that she can ultimately become an engineer. Sanaa seems to not have the qualities that are equated with being an engineer, and for that reason I would rate Sanaa as having low attainment. The question I am left with here though, is what impact does holding a low attainment value place on Sanaa's level of motivation to become an engineer? But how far can we leverage a student's attainment value in this way to better understand their degree of motivation? Matusovich et al. provide an

example for their operationalization of attainment, "I am a problem-solver and engineers are problem-solvers" (Matusovich et al., 2010, p. 294). Applied to Sanaa's experience, what does it mean to Sanaa when she has her own fears and misgivings, and also hears other people's interpretations of her identity that actually might oppose her personal value of attainment?

Cost

Cost for Sanaa seems to be very focused on what it means to be an international student in the U.S., but this does not seem to be unique to the pursuit of a degree in engineering. Sanaa's conversation around what might be pursuit of an engineering degree specific cost, are about the time and the dedication needed to function and advance as an engineering student. Sanaa references moments of sleep deprivation, one of which saw her pulling an all-nighter to study for a test. The day of the test Sanaa was so tired that she felt like she was drunk, and the effects of her exhaustion and confusion were even noticed by her classmates and friends who made it a point to check in with her to make sure she was alright. This lack of sleep, while common to each of the interviewees in this analysis, is no small cost for students to have to pay as we can see that it affects a student's performance, mood, and resilience as they try to advance through the program. Additionally, Sanaa feels a disconnection from home and support from family as she has a substantial amount of disbelief about her ability to succeed in the program and in engineering in general. It's clear that Sanaa feels pressure to perform well in her engineering classes, and notes that the cost as she moves higher and higher into her electives sequences, is that she feels more and more isolated, more and more sequestered to her department's building, and in the lab at all times. Also Sanaa sees studying and practicing math as something that she has to endure, and something that she has to sacrifice her time to, to find a way to perform well for tests, so that she can ultimately

graduate. Lastly, Sanaa notes the cost of taking on a larger and larger course load from semester to semester, in order to graduate. In this case, Sanaa has a low attainment value or reason for pursuing engineering, as the problem solving qualities that she equates with being an engineer do not seem to come to her easily. Coupled with the high cost of sacrificing time and effort for her courses, she seems to be facing a substantial challenge along this path.

Utility

While Sanaa's interviews do not specifically reference the utility of pursuing the engineering degree or engineering as a career track, she does interface with utility in a less traditional way by saying that math as a practice is something that is useful only to the degree that it will help her graduate and get through her courses

Angel

Angel is a Systems Computer Science major from Trinidad that completed so much coursework in high school, that he had a large number of transfer units applied to his degree at UPri, freeing him up from having to take some very challenging classes. Angel feels a sense of community and belonging at UPri because there are so many other students from the Caribbean there around him.

Focused is the way that Angel describes himself. Interviewer: "Okay. How would you describe yourself as a student?" Angel: "Very focused, very hardworking, very self-motivated --." Angel's a capable and academically experienced student, who actually completed a number of his transfer credits while attending high school in Trinidad and

this freed up units and requirements for his first couple years at UPri. During his time at UPri he describes what seem to be extremely high standards he holds for himself, "any time I'll get, I get below 90, I'll consider that a bad academic experience... cause a 90 is not A. I mean, anything below 90 is not a A, and I-- I like A's… because I'd like to graduate with a 4.0 GPA...." In reference to the performance of his classmates Angel also states, "kind of a-- like a [way] to motivate me to do, to, to try to get a 4.0 this semester, because I wouldn't like it for me to get a 3 point something, and next semester I hear that they get a 4.0 ." Angel is academically adept and his high standards and study skills are clear representations of his value of attainment as well. He sees himself as a computer scientist with the skills and abilities to succeed and do very well in his studies and his future work.

> I'm just extremely academically ambitious, and one day, it was one of my friends called me an overachiever because we had a, we had a-, some homework to hand in for econ, while some people they only wrote one page, I did three pages. So that person do one page-, both of us got the same mark, but well the teacher, the teacher wrote [on] my paper that I did a, a very thorough job, and I supposed she was pleased....

The interviewer asks Angel if any of his classes intimidated him and he replied "No. Although computer science and data structures is getting harder. But despite it's getting harder, I still find myself doing very well. And the last two exams, for exam I got a 99 and the exam I had last week I got a 100 so." Angel takes this idea of his level of performance even further, "if I study hard for an exam and I do well, that would be a good experience. But how hard it is for me, if I. Like you know how some people if they were to get a 90 they'd be overjoyed for me, that'd be more kind of normal. But if, if it's a really challenging class and I also do good, or I really study for an exam and I did good,

that would be, that would be a good experience." It seems there's a rater that Angel has inside of himself assessing his daily performance, and although at one point he says "yes, I'm, I'm a bit competitive", he does not seem to be competing with anyone other than himself. "I'm the type of person, I always try to put my best foot forward. Always my best foot, because uh here. Because if I was to do something halfway and I got a half result, uh I wouldn't be pleased with myself." These aspects of Angel's identity fit very closely with his attainment value, as it seems he's been able to succeed in his field of study in every way possible, scoring good grades and completing assignments thoroughly. It's this type of performance that Angel sees as the epitome of what it means to be a good engineer.

In high school he explained that he was less social and didn't participate in student organizations, instead focusing his energy more on his grades as he was unable to do both. He became somewhat more social in student organizations at UPri, and explained that this had a lot to do with actually living on campus where all the action was, as opposed to high school where he lived at home with his family in Trinidad. He did a great deal of STEM preparation in introductory classes in Trinidad as well. Angel came into UPri with 16 credits that allowed him to place out of "Cal, Cal 2, Phys 1, Phys 2." The interviewer notes "Ooh, so you don't have to take Physics 2, huh", and Angel states "I was so happy, because right now I have some friends who are taking Physics and they are pulling out their hair." Angel explained that he ultimately chose UPri over other schools, as UPri offered him a scholarship. But he also considered attending UPri because of its high ratings as one of the best of the HBCUs. Additionally he was drawn to the school because he had family in the area and saw [Branch City] as a very active and lively place. Angel's father, while not an engineer worked in water filtration, and the two of them shared interests in what seemed to be the intersection of his father's technical work, and

their love of science fiction, so Angel saw these as some of the original reasons he was drawn to engineering.

Angel's values of interest and attainment are well represented in the way he describes his skill in mathematics. "And plus I'm good at, out of all of the subjects in general, I am ba-, basically best at math. And I would've taken computer science at A levels, but I knew when I come to the university here that I would've taken computer science as a major, so I said it's best I extend, I extend my knowledge in math by doing further, further math excuse me, instead of computer science." For Angel, he recognizes that he is good at math and rather than resting on his laurels he pushes himself to get better at this field. When he refers to A levels, he's speaking about courses back home at his Trinidad high school that seem to be similar to advanced placement courses in the U.S. The General Certificate of Education (GCE) is a subject specific family of academic qualifications that awarding bodies in England "and crown dependencies including Trinidad conferred on students and the GCE is composed of three levels" the A Level, or Advanced Level being the most difficult to reach. Trinidad gained sovereignty from England in 1962, but it seems that much of the language used to describe levels of the educational system have remained ("General Certificate of Education," n.d., para. 1).

Additionally, math is not the apex of Angel's aspirations and goals. "I really, really like math. In fact I'm very good in math, but it is just simply because I do not see myself doing math for the rest of my life… just crunching numbers and stuff. I just could not see myself doing that for the rest of my life so [inaudible] math and computer science [inaudible] some on that, I might consider to do that." Angel planned to study computer science, and felt capable enough to take advanced placement courses in this field in high school, but instead went further in math as he knew he could explore computer science once at university. So clearly Angel has enough of an interest in the field of math, and he

has practiced math pretty extensively even before getting into college. He also understood early on that he was interested in computer science, so planned even before attending university to make this his major. But added to this interest is the value of attainment, the fact that this student knows he is capable in the field of math is also validation that he is adept at a skill that engineers are known for being good at. "For me, it's all the same thing. It's all the same thing. Because engineering involves a lot of math, it involves a lot of physics, chemistry, according to which field you are going to. It's just that engineering in itself... they s-, specifically deal with building and maintaining stuff. So for me, it's just generally the same thing." Angel is self reflective, he is confident that he not just very good at math, but very good at performing well in school overall, and he shows this confidence when he references his performance in high school and college. "I was kind of how the same way that I am up here, I was very dedicated to my work, very focused. Got good grades also." In addition, these values fit into Angel's definition of his own identity. He sees himself as a good student, very capable, very dedicated. It also sounds like he's found reinforcement of this identity from his environment, completing advanced placement courses back home and doing well in them.

In addition to being tied to his view of himself, his identity, Angel's interest and attainment are also well tied to his interpretation of what is valuable and useful about pursuing the fields of engineering and computer science.

> Well. What I really specifically chose was computer science so and uh for me, I also as a-, despite I like physics-, okay. How, how it is, I like physics more than I like computer science right, but not by much. But from how I see it, I felt that I would be better in computer science, one. Two, in the job market, there's more room for computer science majors, from how I see it, than for physics majors, especially back in Trinidad. Back in Trinidad, we don't have any kind of way to

> research [inaudible] anything like that. So if I had a major in physics, I w-, the most I could've seen myself doing was to teach. Where with computer science there is a whole world of possibilities, I hope one day. So that is why uh I, um, chose the engineering...

In this instance we see that Angel feels interested in physics, math, and computer science. More specifically he believes that computer science will give him more opportunities for work as he can see that there is a demand for computer scientists back home, as opposed to what he sees as the lack of a need for physicists carrying out research in a field that he believes is underdeveloped back home in Trinidad. Angel sees further differences between the U.S. and Trinidad in the world of computer science as well though.

> "Well up here I'll have a, a lot more opportunities. Trinidad is never gonna be as technologically advanced, and the field that I am getting into is basically tech-, technologically oriented. So and plus all of the new discoveries or progress in computer science will be basically made up here. So I really would, would really like to be in that light. So what in fact I would like to do, if, my dream job would really be to work for either Microsoft or Intel... well they are the major computer industries… well, I would have gone straight for my doctorate, but um from s-, I was talkin' to someone, I can't remember who, and he said that the masters is a ideal space to stop because with the doctorate, the higher you go, the more specialized you become. So although you would be paid more as doctor the job opportunities wouldn't be as, uh, as many, because you have become so specialized and the job opportunities wouldn't be as many, while with a masters, with a masters you are still kind of open and plus whatever, really counts a lot is a j-, is work experience. So I don't want to go straight quite-, if I'm going to go for, for Ph.D., um, let the company I'm working for pay like whatever to do my Phd.

> But uh as it stands right now, I just want to stay, shoot a bit more for the master's."

Angel sees the utility of pursuing an education and a career in computer science, as it gives opportunities to work at the cutting edge of technology in the U.S. The qualifiers here are one, that he not go beyond a certain level of education that yields the best return on his investment, that being access to good jobs and two, Angel also sees the pursuit of a computer science path possibly creating a challenge for him when it comes to his citizenship, which we also find plays a big role in how he defines his identity at UPri. "Although, although Intel, I might not get into Intel because I talked to someone from Intel when it was, when they had the, a career fair, and they said for, for international students, they only take any international students with they doctorate, and I only intend to go up to my master's."

Angel's major is "Computer Systems and Computer Science" and when asked how he chose the major said, "I just I like the computer - I got so fascinated by hackers. And in fact, I guess that is the only reason." Angel notes that he's interested in "software design engineering" and he has a strong interest in computer science, at first stating that he does not know what type of job he ultimately wants to do, but in the same breath laying out a job path that is very specific and one which is targeted for back home in Trinidad.

> What type of job I could see myself doing, I honestly-- have no idea. As, as to specifically what type of job will I want to be doing. All I know for myself is that I just like computers, I like computer science. So whatever job I could get, I would take. But I think what I want to become in the long run, is a systems analyst, but in the short run, I'll have to start from something small and then build it from there. I'm-, yeah, and that's my, that isn't fixed in concrete. One of the

> things that I want to do is after I get some experience and some money, I want to open up my own computer business somewhere back in Trinidad. But I'm not so sure exactly what I specifically want to do....

Angel goes on to explain why he specifically chose computer science within the field of engineering, as it lended him the opportunity to be more creative while engaging with projects he enjoys.

> I considered mechanical engineering but it is like -– any other kind of engineering, really, was it suited me because from how I see it, any other engineering is more like you lose yourself, I mean, generally you stick with that it kind of becomes monotonous, those kind of things ultimately if you continue that way. While with computers science, once you are given a different project and then you program what you needed to write. So in order to write that new program, you need to think of ways to write the full program. So it is something that continues all the year like sparks of mental creativity [inaudible] the one and in that sense you like the thing [inaudible]. So I guess that is why computer science I guess is one of the best.

As with many of the students interviewed, cost plays a big role in Angel's description of his path at UPri. "My first year has been hectic. From what I've heard, freshman is supposed to be the easiest year, right? But for me, my year wasn't particularly easy. [In fact I can say] I have been working the same workload a, a junior or a senior would be working... but I've spent a lot of time doing, most of my time-, if you were to ask me to describe my week, it would be divided into eating, sleeping and doing work basically." This is a description of a workload that continues into his fourth year of college as well. In this first year of college though he references going to sleep late at night, and he does

not seem to be spending his time on much outside of school work. "In a typical week, I have a lot of work, I can't remember the last time I went to bed before half past twelve. Yeah, I can't remember the last time."

But it also seems that Angel's well-founded pride in his performance extends to the colleagues and classmates around him, too. Instead of referencing moments of direct competition with others, he notes that his class cohort has been recognized by his professors as being above average, as well. "Our, our this year, our, in my class, is one of the best class [UPri] has ever had. Because uh the last semester, for two of our computer science classes, two different teachers told us the same thing. [inaudible] class, on a average, between 40 and 50% of the class has an A in class right now." And this is how Angel's competitive nature exists within the walls of UPri, not as a way he interacts with others, but instead by how he sees what he has been able to accomplish within a group of other students that are also adept at their studies. "Might not say we are competitive, we're not openly competitive it's just like I use that as a gauge for myself. They, I'm sure, strive to maintain a 4.0 or whatever but I, we aren't really openly competitive." But again, this mentality remains an internal attribute of Angel's, as the interviewer asks if everyone else was maintaining a "B minus average, would you still try to get a 4.0." Angel replies "yeah. Because once you actually have a 4-, once you lose a 4.0, you can never get it back. So they are just kind of like over-, they are, they are just more like--something to push me even further."

We see evidence of Angel's identity as it extends beyond his department as the interviewer asks Angel to compare his engineering colleagues to non-engineering classmates he has. Angel responds "well, with that question, I could see, yes, in that my friends are just more focused, yeah so, they are focused. Yeah we've got more focus, we are more dedicated to our work. And I suppose that could in part be because of the fact

that we are all on scholarships here, and by the way, all of them are Trinidadian so I think that also. So it could be the fact that we're, we're on scholarships or we haven't come here to slack off, we have something to maintain." As he describes the difference between non-engineering and engineering students, and goes further to stress the intention of scholarship funded engineering students, you can see that Angel has not come to college to play, Angel has come to college with a clear intention to become a proficient, high performing engineering student and ultimately an adept engineer.

For students like Angel the values of identity and attainment are clearly connected to both being an engineering student, and being an engineer. Angel distinguishes he and his classmates from non-engineering majors even further,

> I'd have to say that in engineering, people tend to be more focused, because... and well, this, this boy made a comment. He saw this next boy and say he never saw [inaudible] before. So a boy say, "He in engineering?" So the boy say, "No, no I'm not." No one [ever sees] engineering students, but in arts and sciences, he says, "Well [inaudible] he say that he's in arts and sciences," and he always seen him. So from what I implied from what he said, is that generally, engineering students, they tend to be doing more, a lot of work rather than arts and sciences, and as opposed to the other schools, schools of businesses or whatever. Tend to not have as much work... so for that reason, and plus, from how I see it, engineering students are intently more focused....

He's noting here that engineering students are so dedicated to what they do that one never sees them. Engineering students are in lab or in class or in some other place, with their head in the books at all times. This high performing, constantly working picture of the engineering student seems almost impossible to parse apart from the way that Angel sees

himself as an engineer in the future, as this is what engineering is about to him, being focused, being dedicated, and doing the work at all times. The interviewer asks Angel "what would you say that you think it means to be a good engineer." Angel answers "I would say everything that, I mean, focusing on your school work, focusing on your classes, handling their projects on time, hard working. Yeah, that is it."

When the interviewer asks Angel more specifically what he believes makes a good computer scientist he states

> First of all, you have to have good problem solving skills. You have to have-, it's a necessity to have um problem solving skills. That, that is the main thing. And well you have to be able to think logically, and you have to be able to think [inaudible] I think on analytically as well, sort of thing. But you have to be able to remain focused and go, go through things step by step, and not lose focus. Cause sometimes you might have, you're working on a problem where you have to trace a program, and you have to check the value of the thing at each stage in the program, and if you aren't focused, you could get lost and just lost value, or lose what it is you're doing sometimes, [inaudible] do a loop or whatever. So you really have to remain focused and well, yeah, that's basically it.

So we see here this idea of focus that Angel has stressed as being one of his main attributes at other points in these interviews, the ability to focus on school work and on performing well in his courses, is also at the heart of what he believes it means to be a good engineer. We see that a huge part of what he has represented as his identity is inexorably tied to his value of attainment. How well Angel performs in school by focusing on his work is a measure of how good an engineer he will eventually become. "You have to be very much methodological. You need to have a very high sense of focus

because a test could be -- there is something that could become monotonous. There is something that you need to be able to maintain a high sense of concentration on what you have to do, very detailed on what to do, very careful and all of those things which are things which are qualities which I possess." Furthermore, Angel's references to problem solving are peppered with specific examples of how he has applied it in school, and these examples are then tied to the problem solving skill that an engineer would apply during her career in the practice of her craft.

> "For problem solving, it doesn't matter what you, what-, when you get a job, what-, one of the things you're gonna be asked to do, be asked to do is to maintain a system, maintain a program, and the thing you're gonna be asked to do is to write a program. To write a program is kind of like a problem. It's not like writing an essay you have, you have to ensure that the program does what the user specifies. So that is why it is necessary to have good problem solving skills because the problems aren't easy. They aren't easy, it involves a lot of thinking… so that's why it's necessary to have good problem solving sk-, it-, to solve the problem that the user gave you."

Angel takes the focus idea just a bit further as he is asked what advice he would share with incoming engineering students. "Pursue your goals, maintain your focus. Try to g-, try to get involved with computers from now, don't wait til the, you actually start your major to start learning about computers, use the internet a lot, try to learn from the internet itself. Don't always rely on those-, try to be self taught. Don't, don't always depend on others to teach you. You have to have the motivation to get-, go out and teach yourself." We see him reference the idea of focusing, but he also suggests that students take a path where they are in control of their own learning, and this clearly characterizes the path that he has tried to follow since beginning to study math and engineering. "Well,

major importance is that we gain knowledge-, I'm talking about self-taught as opposed to not being taught, I don't know, something that they wouldn't be-, not learn in classes so that is just generally increase your knowledge, and as it's said, knowledge is power." And really it's an ownership of the knowledge and learning that is most important to Angel, as there are actually very few places in his interviews that he references his experience with professors or their teaching. "And most importantly, do not leave the responsibility of your learning up to the teacher and show that to yourself."

There are multiple points at which Angel refers to the cost of being an engineering student as well. An early example highlights the way that computer science classes specifically take precedence over other non-engineering classes for him. "Computer science has been taking up a lot of my time, a lot of my time, having to write all those programs. Right now, I have a program due today but that was due today. I'm finished. Oh we started last night. So computer science has been taking up a lot of my time, so because of that, I haven't been able to focus as I would've liked to on the other, on the other subjects so because of that I've kind of, have lapsed in Chemistry, yeah." And as commonly stated by the other students in this analysis, engineering school work has a major effect on sleep. "Well what I, what I often tell my friends is that sleeping is a luxury, so if I have to get work done, I just sacrifice sleep. So most of my days, I only get around four hours of sleep." But Angel also references the importance of doing things outside of engineering. "I think the most difficult thing might be trying to make time for myself." While it seems to be a struggle, managing work and time for himself, he does see the importance of having some release. "One day, it was sometime last week, that it was extremely necessary. I had a lot of work to do, I couldn't afford to waste time, yet I still went to chess club just to ease my mind. Because it wouldn't make sense to burn out myself and [inaudible] because for myself, sometimes it's necessary to stop and relax and take time, time for yourself." Angel references many of the ways in which his studies

take precedence, and while this can be one of the many costs to being both an engineering student and to being an engineer, it's this cost that he also ties his identity. "But I would say engineers are more hardworking or could just maybe because we generally feel that it is one of the most difficult majors on campus, so they sometimes like we feel sometimes "have a social life" while sometimes you feel a sense of urgency like just kind of lack [inaudible] make it into the night practically doing nothing while we basically always have work to do or have some projects or something that is up." Sacrificing a social life for a grander purpose is both cost and identity for Angel. While other majors have time to do what they please, engineering majors have to remain focused on what they've come to university to do.

In comparison to many of the other students in this analysis, Angel is less focused on involvement in student organizations. "NSBE, honestly I have kind of neglected NSBE. Although for next semester I want to get more serious with that. But I haven't really been going to NSBE meetings or anything like that. I'm just a member." But we find that in later years Angel takes on some substantial student organization positions. "Right now I'll be the interim vice president of the entire school in ACM. The whole Beta Phi last semester, I was the [inaudible] of the Beta Phi." While Angel doesn't stress the importance of communication in the classroom or the workplace when it comes to being a engineer, he does describe it as a personal area of growth for himself. "One of the things is that I have to, have to make better my communication skills, my leadership skills, communication skills and leadership skills and [mumbles]. And I have to become a more proactive person, because despite how I operate, I'm kind of a laid back, can be laid back at times." Angel also applies some of the same class performance and studying strategies that other students in this analysis have applied, i.e. talking to classmates and more senior students about which classes to take. "Uh, I talk to my friends and then I would talk to other computer science majors, I'd ask-, yeah I'd talk to other computer

science majors. Because what... oh they have it next semester, I'm doing advanced data structures, right? So the spring semester's... advanced data structures spring next year but I'll pull it up to fall so that in that semester, I won't have to do any computer science courses." Additionally, he would seek out advice on how to balance the workload of challenging classes by spreading them out over his time at UPri. "And last semester when I was picking my courses for this semester I was, I was going to have it-... but the person advised me to not-, I was gonna take it extra light this semester, but next semester I might have had it kind of heavier, but the person advised me to try to balance the workload schedules so, so by pulling up classes and-, I'll make the workload lighter later, later on. So that-, so I talked to him for advice about that."

Angel describes his understanding of how he feels students from the Caribbean successfully function at UPri due to their prevalence at the university.

> But also we're, all of us Caribbean students here are away from home… we wouldn't miss home as much. Because for me, since I've come up here, I've never been really homesick or anything like that. And p-, and the major reason for that is because there's so many people from the Caribbean here and from Trinidad itself here. Because if I'm up here and didn't have any Trinidadians or the people from the Caribbean once I got-, I would've been homesick. So that's, is most of the reason.

This quality of being an international student seems to play a very large role in Angel's understanding of his own identity at UPri and in the U.S. overall. When asked if gender plays a role in engineering, Angel's assessment of his experience is that "both male and female students have equal opportunities, but uh it was a-, um, I don't really think so, no." When the interviewer asks Angel what ethnicity he is, Angel states "since I'm up

here I'd have to say African American, I don't know... okay, a Negro, a Negro. No because African Americans is the term they, they use up here... I would just say, no one ever asked me that before but, but I would just say a Negro." The terms that Angel flips through as he looks for the way to represent himself are interesting in that African American, for many denotes american citizenship, while it seems that Angel is not a citizen of the U.S. He then moves to the term negro, which for many is a very antiquated term tied to the Jim Crow era. He does not immediately default to the term Black, and instead begins to describe his international student status, and some of the affordances that being from Trinidad have provided him. "But um being a Caribbean student, any advantages... well for one, it is said that Caribbean people are, the level of education, like high school and pre-high school whatever for Caribbean people is better than that for Americans, that is a general consensus." Being an international student from Trinidad also becomes a major part of Angel's definition of his identity, mainly when he speaks about the work limitations that having this status brings, and the cost that is associated.

> "Um, this main disadvantage would be not being an American. For one, in terms of job opportunities and internships, some of the internships require that you are a US citizenship, a good deal of things require that you're a US citizenship. Also, in terms of relating to other people, for me, most of my friends are people from the Caribbean and sometimes I find it kind of hard to relate towards Americans, sometimes. I don't know why but for some reason. So in terms of that just kind of breaking that communication barrier, sort of barrier, or whatever you want to call it. In terms of that, that would be kind of a disadvantage."

While he does not immediately refer to being Black, he does point out the privileges attached to being white in a white dominant country. When the interviewer asked what the experience is like for other ethnic groups Angel responded "I mean [inaudible] but for

white it has generally an advantage since America is a white country." When Angel ignores citizenship status and focuses on the variable of skin color though, he sees some advantages to not being white. Angel states "for example, when companies need to have a certain percentage of blacks on their [inaudible] or whatever. And that is the advantage that could be seen on [inaudible]." While international student status is brought up by other students in these interviews, Angel's seems very influenced by the September 11th terrorist attack on the World Trade Center and the U.S. government's response to immigration.

> "Well it doesn't really affect me now but, for like-, from one of the changes that I understand-, I understood that they made, is that we don't have the amount of privacy other people might have. We don't have that. We, how it is, they have to be able to check our every movements here in the United States, every single movement you make, if you make a trip, anything you do they have to be able to check that. We have to let the ISS office know whatever we're doing. If you get a job, they have to know. Anything you do, they basically have to know. Anything of n-, significance."

Angel sees a very significant difference in how he will be handled by government officials in comparison to students that are citizens of the U.S. "The only thing I could think of it affecting me, is in terms of privacy, in that-- if I don't know what specifically, but let's say I do something [innocent] that any other person could do an American student, because I'm a foreigner, they might want to investigate it further, put it in my files or whatever do whatever you have to do [inaudible]."

Interest

Angel seems to have a clear interest in mathematics from the extensive extra coursework he completed in high school, that actually seems to not have been required for college admission. There's a point in his interview where he talks about being very accomplished in his math courses, and having the opportunity to take computer science programming courses while still at high school, but consciously deciding not to, so that he could go beyond the required math curriculum. It seemed that rather than just accepting the fact that he was good at math and resting on his laurels, he wanted to challenge himself even further by going into more complex math courses. It seemed that this decision for him was twofold. First, he thought the challenge was the interesting part of the whole process, challenging himself to do even better in classes; and second, performance-wise, he wanted to make himself an even more competitive candidate, not just in college but for his future career in engineering. Neither of these reasons for pursuing more advanced math fit very nicely into the interest value box, but this is how interest seemed to manifest for Angel. We see that Angel had a very clear interest in computer science and math, as he chose his specific major long before entering college to give himself experience in both of these fields but Angel does not seem to explain for us why he had these interests. At the most he explained that he had just been fascinated by computers and by hackers ever since he was a child.

Identity

Angel identifies himself as focused, hard working, and dedicated. He holds himself to a standard of achieving As and a 4.0 in his classes overall. Angel calls himself extremely academically ambitious and goes the extra mile when he completes an assignment, whether he believes it's going to land him a higher grade or not, as he holds himself to a

high internal standard. In high school Angel was more focused on academics than social affairs, and at UPri remains focused on academics, but finds himself more involved in student organizations, as he's on campus at all times making meetings easier to access than in high school. By way of expressing his feelings about his own identity, Angel identifies his class cohort as being one of the most high achieving cohorts at UPri to date, as two of his course professors explained that 40-50% of students were pulling down an A in the class, which had been far less common in years prior. Culturally Angel identifies as being from Trinidad and as a scholarship student. As he's on scholarship he feels that he has a more definitive goal for success, for example keeping his grade point average up, and advancing in the program accordingly. Angel explains that students attending UPri on scholarship have something to maintain. Angel believes that engineering students in general tend to be more focused. He supports this with an anecdote in which he saw someone on campus and asked a friend who that person was. Seeing someone he'd never seen before, he then implied that he must have been an engineering student and that's why he'd never seen the student before, the important point being that engineering students tend to be doing more than other majors and are therefore nowhere to be found. Angel seemed to describe this story with some degree of pride as he tried to distinguish engineering majors from art majors, implying that art majors have all the time in the world to do whatever it is they want while engineers are struggling and working. Lastly, Angel identifies with being from the Caribbean in general and Trinidad specifically, noting that his upbringing has given him far better academic preparation during high school to succeed in engineering at UPri. Lastly, Angel expresses that as an international student he feels that he has less privacy and freedom especially since after the September 11th terror attacks, the U.S. government seemed to have cracked down on people from other countries, monitoring them more closely.

Attainment

Angel's coursework and competitive grades help him to define himself as a successful engineering student. It should follow that Angel sees himself as having the potential to be an engineer as he sees his own performance and course-based merit serving as evidence that he can be successful in the field. Essentially he sees himself succeeding as he practices some portion of what an engineer is required to do, and the practice of mathematics for his courses is a good direct example of that. Angel took advanced level mathematics back home during high school, and as I noted earlier, rather than choosing to take computer science classes, and instead, chose to take more math courses in college to become more deeply proficient, hopefully supporting whatever future line of work he goes into. Angel believes that engineers build and maintain software products. In his mind that is essentially the scope of their work, and he believes that he is extremely proficient in those practices, so can clearly and confidently see himself as an engineer. Problem solving is an additional defining point for engineering and Angel notes his ability to solve problems. He speaks about his practice in maintaining systems and writing programs, and how these are clear examples of problem solving that he will continue to do as he begins a career in engineering. Angel's attainment is very high, as he has multiple reasons for pursuing engineering that are related to being the type of person that is an engineer.

Cost

The cost for Angel, as it is for many students is the huge amount of work that needs to be done as an engineering student, as well as the the toll it takes on the amount of sleep that he gets on a daily basis. An additional cost that Angel notes is the amount of time that engineering study takes up and the effect that it has on his performance in other classes

outside of engineering. He notes specifically that at times he's had to sacrifice his performance in a class like chemistry, for his performance on work for an engineering class. Angel also finds himself unable to make time for himself outside of his school work. The cost of being this hardworking in engineering is not having a social life, as there is always something for class that needs to be done, or worked on with a sense of urgency.

Utility

Angel believes that computer systems and computer science will prove to be lucrative enough, as a career for him to eventually own his own business. He also believes that pursuing a career in computer science will afford him more room for creativity in the engineering work that he ends up doing. And he chose to pursue computer science because there was a competitive job market for it, both in Trinidad and the U.S. but he emphasizes, especially in the U.S. due to all the technological innovation that regularly happens there. Angel notes that he could have pursued a career in physics research, but does not believe that the jobs attached to these majors actually exist, or will grow anytime soon in Trinidad. This played a big role in his choice to go after the job path that was more lucrative, and that had a higher demand for graduates.

Roxanne

Roxanne is an Electrical Engineering major from Detroit, and focused on experiencing life outside of the engineering department as much as possible. She came to UPri because she wanted to be in a diverse environment with lots of different types of people. She feels ill prepared by her high school math and science courses and feels outmatched by

international students. She pushed herself to get as much practical hands-on experience while at UPri, to the extent that she accepted a year long co-op position that pushed her course schedule a year back. Roxanne believes that a small amount of theory coupled with good hands-on practical experience, will make her a good electrical engineer.

Roxanne is focused on “just having fun, I try to have as much fun outside of engineering as possible because it’s college life so." This recognition that she’s experiencing college life stands out in Roxanne’s interviews, as her earliest intentions around attending UPri had little to do with studying engineering. As with other students in this analysis she was originally drawn to engineering by an interest in a more generally defined area of technology. "Um, gadgets an’ just being a little bit younger and playin’ around with stuff... Cameras, cell phone, computer… I was pretty handy with it." And Roxanne had a chance to practice working with technology in this way as early as middle school, “jus’ being in different programs like when I was in middle school an’ hands-on experience basically, just as young bein’ exposed to that type o’ stuff." In reference to why she chose Electrical Engineering as a major at UPri, "That’s where, like, electronics, the exciting stuff that I like – electronics ‘n -, yeah, that’s (inaud) got me in gadgets. (laughs) So I knew I wanted to work with that." It seems that it was also Roxanne’s hands-on mentality, that stopped her from exploring computer science as a discipline of study, "Computer, you have too much coding – like software stuff. I like to see what I’m working with most of the time." This hands on nature also seems to have guided her to pursue a co-op position, which enabled her to work during the school year and pause her progression through her courses during her third year of study. "Well, I get a co-op for a semester, so that pushed me back a year." Although the co-op affected her class schedule, she believes it should be something offered to all the students at UPri. "Um offering co-op experience cause we don’t have a actual program it’s like if you get one, OK that’s your business…” She stresses the importance of programs similar to the co-op near the

end of her very last interview, when asked for feedback about UPri's program overall, "Um, I would say only givin' them opportunities to do a internship, because jus' being here – no. You're not prepared." Here Roxanne is explaining that the educational program at UPri is not nearly enough to prepare students for industry jobs, emphasizing the importance and the impact of programs like the co-op and like the internships she'd had access to. Another comment that Roxanne shared that seems to go hand in hand with her suggestion that students have exposure to work experience, is focused on what she sees as antiquated facilities and tools at UPri.

> Um, I would definitely say bein' (inaud) school (inaud) technology... The whole curriculum needs to be changed, basically. Um, like, bein' an Engineering student, you 'posed to have, like, the top o' the line stuff… But, (inaud) computers that work, certain equipment that you will use in the industry you should have here… or classrooms are from like 19, like, 67 or something, (laughs)... Bein' a Engineering student not seein' technology is, like, the worst, so… and improving like the conditions of the building because technology-wise we're way way behind, so.

Roxanne employs the same curriculum strategy that others in this analysis have employed, seeking advice from classmates and more senior students when it came to what classes to take and when. "Oh, you jus' ask the upperclassmen. Yeah, (laughs) you definitely ask the upperclassmen." She's involved in student organizations on campus as well. To that end she also employs the strategy of being selective of what professors and classes to choose, "Basically the teacher I kinda get the best teacher or the easiest teacher I guess you could say. Um so I guess that's one of the big strategies or getting some courses out of the way or taking them in the summer." While she describes herself as being very determined and hard working, she faces many struggles in her studies while at

UPri. "Mm, just determination. Um, other than that, nothin' prepared me (inaud) (laughs)... Um, I think if I went to a school with a better math and science program I would be a little bit more prepared or a little bit more exposed toward the Engineering aspects. But it didn' hit me (inaud) (laughs)." Roxanne states outright multiple times "math was always like a weak area."

Roxanne is an electrical engineering major who came to UPri by way of Detroit, Michigan where she attended high school. She describes the two cities, Detroit and [Branch City] as similar, "um transition was a little bit different cause I'm not from [Branch] but other than that, I'm from Detroit so. Um it's much faster than—well not much faster, they're both like inner cities, but it's a little bit faster here than it is in Detroit." Roxanne unlike the other students in this analysis decided to attend a practicum or an engineering co-op in her third year of study, during which she takes time off from coursework and actually works as an engineer off campus for an engineering company. "I'm well, I'm doing a co-op currently and it's giving me a lot of practical experience and basically um just getting practical experience this semester." This decision to practice her craft before finishing her degree training, coupled with extensive comments regarding her identity as a person that is more focused on doing and practicing engineering rather than understanding the theoretical side of the field, distinguish her experience from that of the other student interviewees explored in my analysis. "Well um first off I'm not like a theoretical person, so I'm really hands on and this co-op provides that." In one sentence Roxanne seems to sum up her values of identity, attainment, and cost all at once. The interviewer points out that her current position in the co-op means that she has a full time job, "yes, it is. It's it's better working in the industry than it is going to school. Yeah." This is a short statement that just describes how she feels about working versus going to school, but her characterization of her school experience during the rest of her interviews defines her identity as a person that was not well prepared in high school to deal with

math and science classes at UPri. Her disliking of class and school work, do not hinder the strong attainment value she seems to hold for a career in engineering, as she's found a way to work before completing her degree and she's classified her school work as theoretical, and in many ways not necessary to her engineering practice. Lastly, although reticent, she is willing to finish the courses and sacrifice so much of her time and daily life to finishing the degree so she can go on doing what she's been doing for the year, practicing as an engineer in the field. This opposition between theory and practice that Roxanne is working through is even more interesting as it intersects with her value of interest.

By her last year in the program we find that Roxanne's dream job is not being an engineer, but rather a small business owner, more specifically a restaurant owner. Let's unpack this interest conundrum by first looking at the areas of engineering that Roxanne finds herself disinterested in. When she reaches her junior year and reflects on the work and study that she has carried out for the last two and a half to three years she states, "uh, I guess how-, like, I don't have as interest that I thought I would. A lack of interest, I guess, would surprise me." She returns to some of her more foundational interests from her youth, i.e. an interest in technology and electronics. "Cause I thought I'd be all into it since I like gadgets an' stuff. But I realize I'm not theoretical at all. I guess you could say junior year 'cause that's when you get in the bulk of your classes, an' it's kinda like, "This is not what I expected." It's interesting that a number of students from this analysis enter the world of engineering because of their interest in what they describe as electronics or technology, but end up being less engaged by some aspects of the engineering process.

For our first student Monica, she was much more interested in social, organizational, and communication practices, but did not seem to equate these with engineering practice. In

this case for Roxanne, she enjoys the hands on practice of working as an electrical engineer but struggles with and dislikes all things theoretical in engineering. This idea of interest or a lack of interest in Roxanne's case, plays a major role in her third year, in part because there is a major transition in her curriculum that year, "when you get to your electives it's kinda like-... now it's like, "What's easy?" Uh, before it was kinda like, "What am I interested in?", but now it's like, you know, to get the grade." Roxane sees the transition into her junior year as the point where one begins taking actual engineering focused classes, and by this point it seems she's given up on pursuing topics she is interested in, and instead pursues the courses that she can get a reasonable grade in. This has to, in some part, be due to poor grades in earlier semesters and her need to have a grade point average that qualifies her for graduation, but it's interesting to see her abandon the notion of pursuing her interests, instead to take courses that she will be able to pass. Roxanne begins to share a picture of where she's likely to end up in her career once she's had some time to work in engineering. "Um, well hopefully I'll work my way up, like, the corporate ladder in a engineering company. But after that, like, opening my own business. N-, non-engine-, engineering-related. But, (inaud)-, like a restaurant – like a jazz-type restaurant. So um, yeah. Givin' back to my community in Detroit, basically." And when asked if she planned on moving back to Detroit she replied, "Oh yeah, definitely. Yeah." These statements are telling, as they show not only some degree of disinterest in engineering, that is engineering is not her end goal, but these statements also help us explore Roxanne's interpretation of the utility of an engineering degree. She seems to feel that having a career in engineering will be lucrative enough for her to save money as she moves up the corporate ladder, and eventually invest in a business that she sees as somewhat self sustaining and far less difficult than the practice of engineering. She describes what her daily life might be like owning that jazz restaurant, "Okay, well I plan on, like, jus' walkin' to my restaurant, wavin' to see if everything's okay, talk to the

manager, an' goin' back home and relax ...(laughs). Yeah, I basically jus' oversee things, (laughs) at that point, so yeah."

Roxanne notes that within the co-op (made up of full time employees and other students), "well, I'm the only [UPri] student right now... it's pretty interesting cause I'm the only like black co-op." And the distinguishing traits that make her different than others in this environment are her race and gender. "But, also just being in a different atmosphere seeing that [UPri] is like a black college and [inaudible] all these white people it's pretty interesting, you have to get used to it." She is invested in this co-op work to the degree that she's let it affect the course sequence of her degree program. "It sets, it's supposed to be a semester but it's a whole year pretty much... Yeah, for once a year. Yeah I mean offered once a year and they don't let you take at any other university so." Although the co-op normally goes for a semester, the fact that it coincides with early sequence classes means that she has to delay some of her coursework, i.e. missing the first class in a series, means she has to wait till the fall to begin the series. This hands-on or doing mentality, which she relates to beginning the co-op position in the first place, also seems to be what drew her into the field of engineering overall. "Um I became interested in engineering, because as a kid I liked to break stuff and fix it. That's the main reason why I'm in engineering."

Roxanne describes parts of her identity by further characterizing the differences she sees between home, UPri, but also Buffalo, New York, the location of her co-op. "And then um coming from Detroit to [Branch] at first, [Branch] was like a way different environment, then I took a look at it like, "OK it's kinda similar to Detroit, as far as like the urban part of it" so I mean I kinda like—being in Buffalo now and [Branch]., I'm like, "Damn, I miss [Branch]" So so it's different... like the people are different from like Detroit and here." One major theme that stands out for Roxanne is the distinction

between learning *theory* and the actual *practice* of engineering. The overall picture of her experience that Roxanne shares, makes her seem very much like a capable and independent problem solver. A metaphor for this is seen in the way that she describes the differences between drivers in the different cities. "Um in some parts some people, it's worse but you know for the most part. Like, [Branch]. I hope you're not from [Branch] but um um the driving is terrible here it is definitely terrible, people do not know how to drive and this whole snow thing cracks me up because they don't know how to drive in snow, rain... it's definitely different than Detroit, we can drive in Detroit." It's a small nod to her capabilities as a problem solver, but it seems to really fit the theme of her story, as she is excited about practicing the concepts she's learned, and is very hands-on. Although she has struggles in some of her coursework it seems that this mentality is in some ways protective of her confidence. She might not understand theory to the extent that others do, but she can sure execute on work and excel in the practice of engineering. This is very interesting because it intersects with both the values of attainment and identity.

When the interviewer asks Roxanne, "What would you say it takes to be a good electrical engineer", Roxanne replies, "Um I guess knowing a little bit of theory and—I guess whatever you're good at I think like if you're more of a practical person I think you need to like be well rounded with building stuff, you know knowing how to build it and how to apply it." Roxanne goes on to describe the alternative, "And if you're a theoretical person, know your theory but have a little bit of practical experience because all theory is not good at all." The interviewer asks another question that gets us closer to understanding Roxanne's level of attainment. "How do you feel that you are at these characteristics that you've mentioned about being a good engineer?" Roxanne replies, "Well, I think I'm--the practical I guess I'm picking up more on it because with the co-op um so I think I'm pretty much OK on the practical part. The theoretical I feel that a little

bit that's work." On the one hand Roxanne believes engineers have to be good at things that she is not currently good at. "My own image of a good engineer was that they had to be like really good in math and science." On the other hand, in basically the same breath, Roxanne makes reference to what professors believe makes a person a good engineer. "I think they think what it means to be a good engineer is basically all this theoretical stuff, cause they push the book on you so much. I think they think if you have all the theory you should do well." But clearly Roxanne can see that her current work in the co-op extends beyond theory to actually carrying out hands-on work. "They think-, um, most of 'em think that if you're able to know almost everything in the book. Like, if you really good with theory, most of our professors think that you would be, like, an excellent engineer." So, on the one hand, she identifies herself as someone that professors might define as unfit to practice engineering. This should, and most likely to some extent does, shake Roxanne's confidence in the fact that she can be a good engineer, but her jumping into work and practicing engineering counters what might have challenged her identity and attainment values. She sees herself being able to do what engineers do in her present position, and that defines her attainment. To sum up this aspect of her attainment and her identity, I'd imagine she believes the following: *I'm good at practicing engineering, engineers are good at practicing engineering, therefore I will make it, and currently am making it as a good engineer.* Another part of Roxanne's value of attainment can be seen in her interpretation of the importance of good communication in engineering work. She believes that while professors prioritize good theoretical skills, they should instead be prioritizing communication skills. "It's totally opposite. 'Cause I feel that a engineer has to be able to communicate, like, get outside the books an' also be able to work with it. 'Cause theory is jus' theory really, so yeah." And this quality of being a good communicator is something that Roxanne believes she possesses.

When Roxanne begins to describe why she came to UPri she states, "So I'd say socially an' jus', like, being (inaud) in another city –that's, like, the best part for me." She goes on to distinguish these aspects from the academic focus of the university and more specifically from the engineering department.

> I didn't come here for academics at first... I came here because the-, um, (laughs) I came here and I was on the Yard an' you jus' see everybody doin' their own thing." Roxanne describes what she sees as a diversity of students on campus at UPri, "Like, the different mix of people. You got your frats and sororities, you got your artsy people on the steps an', so I mean it was jus' like, "Okay, I cou, I could do this." I'm more of a-, yeah, I wanna say I didn't come here for academics. That came after – like, "Okay", you know.

From this we see the impetus for her attending UPri, a reason for going to college that is not uncommon, to place oneself in a diverse environment and explore connections and friendships as you search for your educational and career interests. Additionally, when asked what advice she might share with incoming students, after she's followed this path to electrical engineering for a number of years, she states, "Um, I would tell them to get in a little bit more programs, like, if their want to focus in Engineering jus' to kinda see exactly how it is before you get too deep into it and don't wanna turn back. So, I would tell them to familiarize themself and actually talk to another engineer to see what they do in the real world before they make the decision." This statement is telling, in that Roxanne seems to be reflecting on whether or not she should have followed this path, if it was worth the cost, and if it was genuinely something she was interested enough in. Although it's not directly asked, the reader is left wondering whether given a chance to follow this path again, if Roxanne would still actually choose to pursue electrical engineering.

Roxanne is also social and very much enjoys communicating with others and it's this part of her identity that she uses to distinguish herself from other engineering students. "Oh, like I go out to parties at clubs (laughs). You know, I like tour the city, I travel. So yeah, I definitely do more stuff than Engineering." Roxanne describes what she feels is the difference between engineering and non-engineering students,

> Um, I think we have a little bit more of, like, academic work ethic – like, a different one – because we are willin' to stay up to the wee hours of the morning to do-, you're like doing a-, one math problem. Um, I think-, not sayin' that other people's determination is not (inaud), but I think we get put through a lot. So you-, you're able to handle stress a little bit better in different challenges. So I say that makes us a bit different.

She notes the exemplative engineering student's determination and devotion, to solving even a single problem, no matter how long that might take. She's also noted at many points, her degree of determination to do course work and co-op work, so we see the value of attainment here. Engineers and engineering students are determined and so is Roxanne. She begins to describe what that looks like on a daily basis for some engineering students, and some of the differences between what their days are like and what her days on campus are like. "I'm 'on say a little bit different from me jus' because o' the fact a lotta people are like jus' cranked up in the Engineering building an' that's all they do... engineering activity... So I think I'm a little bit more social." We see that one of the costs of being an engineering student is devoting the great majority of one's time to the effort of studying for the degree. To this end engineering students are in lab working non-stop and getting very little sleep.

> Well, like um. I've got a lot of contact with non-engineering students… so the difference between engineering students and the regular students, engineering students mostly are found in this building like on any given day. Um like I said you are kinda taken away from the campus atmosphere cause you're down the hill, instead of up on the hill. So like on a Friday when everybody out, you're kinda in here trying pass, so. I'd say like they're studying a little bit more than most.

This can play a role in limiting engineering students' social lives and connections with others, inside and outside of their department. Roxanne seems to define herself differently. Instead of being hampered by time requirements, and in the lab at all times, she is social and works to make connections with others. "Easy is-, I guess adaptability. Like, jus' being able to adapt an' being able to, like, seek different organizations that I want to be a part of, or I-. Socially, I'm pretty okay, but… (laughs). So yeah, an' bein' able to jus' talk to my professors 'n, you know, communication-wise I'm pretty good, so..." Roxanne seems to have made a decision early on in her time at UPri to avoid being stuck working and studying all the time, but once she reaches a turning point during her junior year she seems to get more caught up by her workload. "It takes up a lot of time, and I was like, when I first came here I'm like I'm not gonna be in the engineering building to four o'clock in the morning, but once you hit your junior year, or sophomore year you start being in here like six o'clock and you gotta be back by eight so yeah, it's definitely hard."

This workload idea is another differentiator between engineering and non-engineering students. The interviewer asks, "Do you find that your friends in in other majors, they have a lot more time then you do?" Roxanne replies, "Oh yeah, Oh yeah. Oh yes, they barely have class." When prompted with a question about how that makes her feel, "Well,

it kinda like, at first it kinda makes like your friendship kinda like it kinda slows that up because you're always in here and they always out doing something, so you kinda wish you were out there." The interviewer offers an example of what Roxanne's non-engineering friends might say to her, "Come on let's go" and Roxanne replies "Right exactly, so you kinda, you kinda miss out on a lot of stuff actually." We can see more evidence of the cost of pursuing an engineering degree for Roxanne, as she is a social person and the work she has had to do seems to have hampered the growth of a number of her relationships. Though, at the same time, Roxanne uses her social nature to distinguish herself and a group of her engineering friends from the overall group that she identifies as engineering students. Her identity does not match perfectly with the larger group. "Well, some of us like, we're not as like the nerdy engineers type of thing. We kind of like to have fun outside of engineering. So some of us are like that, we're not totally into the books." Roxanne uses her social nature here to further justify why she does not always find herself studying, why she is "not totally into the books." And when she is asked to describe what aspects of her program are easy it's this social nature of it that stands out in her explanation, "easy is just meeting new people I like to meet new people so that was like the easiest part the social part was the easiest."

What seems to have started her on the path to engineering was a genuine wish to solve problems and she explains, "well basically knowing what to do practically cause like I said, I'm not like the math and science type of person. Um just basically wanting to solve a problem and you know fix it. So." She references not being a "math and science type of person" here and states this many times over the course of her interviews. As Roxanne struggles in some of her courses she seems to embody a fixed mindset (Dweck, 2012). A lot of her feelings around struggling with math and science seem to tie back to her experiences in high school. When she's asked by the interviewer what advice she'd give to incoming engineering students she states,

> To get into programs while in school, like um especially cause I went to a public school cause a lot of things are not offered in the public school you have to go out and you know search for it so I would highly suggest that. And you know could build and stuff, cause you know a lot of people when they come here they already built stuff, they already know what this is.

This speaks to Roxanne having wished she got an earlier start on the path of engineering. She goes on to explain that getting started early will help incoming students avoid some of the struggles and challenges she's face. "So you get in programs like maybe a robotics team or something you pretty much you know do well. And seek out other help if you're not good in math or science you should seek out help while you're in high school instead of trying to seek it out later." This advice she'd give to others speaks to the parts of her path that she may have regrets for, as she might not have struggled to the extent she did if she had gone to what she perceived as a better secondary school, or if she'd sought out help early on when she first realized that math and science were challenging for her. The challenges that Roxanne is facing are somewhat shrouded by her description of the situation. The interviewer asks her about tutoring and she states, "but they have tutorial services that's free." The interviewer asks, "Were they helpful?" Roxanne replies, "No, um. I feel that they weren't like—sometimes it may have but a lot of times it's really not helpful—I even like hired a tutor for like calculus and that did not work at all. But I find it when like my peers like if we get together for a study group it's much more helpful than like." So with free tutoring and paid tutoring it seems that Roxanne continued to struggle, eventually finding some degree of success from working with her peers. This might be due to what she describes as having a more social nature.

And as other students interviewed in this analysis, she was drawn to tech and this is where her interests intersect with electrical engineering. "Cause I like gadgets and um electrical is a little bit more I guess interesting than the other ones. I like gadgets, I like electronics so that's why I went into electrical." Roxanne further defines her interest in electrical engineering by describing the aspects of computer science that she is less interested in. "Well computer engineering. Yeah, it's kinda closely and related to electrical engineering... well they deal more with like software like they're software and the electronic side but they like program computers they get a little bit deeper into computers..." Additionally it seems that some of the reticence to practice theory, and the prioritization of the co-op over coursework are tied to her feelings about a lack of support being provided by the professors at UPri.

> Well, pretty much [UPri] it's a good school, but like some of the professors they don't care whether you learn it or not, either fail you or something like that so for the most part I don't think the courses I've took so far prepared me as much as they should have. Cause being out in the industry, it's like I'm way behind the other students.

There are multiple points in her interviews that Roxanne cites poor teaching at UPri and her want for instruction that is more effective at reaching her and helping her understand the challenging content she's slated to learn, "a teacher who is able to like break it down... no matter what level it is – be able to break it down and apply it to somethin' in the real world. That's what I definitely look for." She compares herself to other students from other universities that she works with during the co-op and explains feeling that she is behind them in their understanding and practice of engineering, in part due to professors not being invested in her learning. This is a multifaceted problem she is facing though, as she also begins to further describe what sounds like a fixed mindset when it

comes to her ability to understand engineering and math theories (Dweck, 2012). Additionally, Roxanne has positive things to say about a set of professors at the school though, especially in terms of her ability to access them when she needs them. "Um well, the professors, well most of them are pretty approachable. You can keep in contact with them as far as like what you need to know so they're pretty more, like they are approachable and the classes are smaller than most universities so." But it seems that the conflict of the problems she faces with classes and professors is tied to challenges that she has had with content as well.

> Oh well yeah, um teachers not being able to teach. They like lecture but they don't know how to teach the students or bring it down to your level. Had a couple experiences like that um and it causes you to get like a D in the course or something like that. Yeah, so. I think that some professors are too intellectual and they can't articulate to like a common people.

This idea of "common people" speaks volumes as Roxanne refers to needing additional help to understand course content and her challenges with poor performance in classes.

> Um probability and statistics um. That's one of them it was electromagnetic theory was another one, and basically I got a C out of that and like you, if you got a C or a D you was like just set. You know what I'm saying, yeah cause it was crazy. Let's see the electronics one it was crazy.

But it seems that some of these challenges are both about the curriculum, and it being accessible to students that have struggled with some of the concepts presented. The other side of Roxanne's story is about her reaction to these struggles in classes, i.e. how she modifies her studying practice or does not modify her study practice, how she copes with

the struggle, and either attempts or does not attempt to improve her performance in classes. And I emphasize the distinction between her performance in classes, from her performance in her co-op, as it seems that other than feeling somewhat less prepared than other students in the co-op, she seems to have performed well there. Her performance in class versus the co-op and her assessment of her performance in each venue is well described by the following statement, "well, like now I am like reading the stuff. When I'm in school, I'm not like a reader or anything so I just do, you know what I need to do to pass." And Roxanne's perception of her lower performance in class is interesting as well, as she believes that she can get a good number of D grades, without that having an effect on her degree progress. When asked about whether or not those courses that she scored a D in needed to be taken again, "well, it's like you have some classes to get a D in, in engineering I think it's like you can get like five or something." These ideas play very clearly into her own definition of her identity, and over the course of her interviews it does not seem like this part of her identity, exemplified by the statement "when I'm in school, I'm not like a reader… I just do, you know what I need to do to pass", is affected by other students, professors, or family members' perspectives of her identity. "As a student I can say that I'm really laid back. I'm not like a bookworm so like I got the—I do what I have to do to pass but I'm not like an overachiever in school." As Roxanne describes her grades and her process, it's clear she's not an "overachiever", she does not really seem to be an achiever when it comes to class either, and this seems very different than the other student experiences covered thus far. But she also attributes this to her lack of preparation in high school, "well, like my math and science classes I kinda had to do like a little bit more than everybody else cause like I said my background wasn't that great in math and science but just working hard, like going to professor on that one." So on the one hand she describes herself as unprepared in math and science, and in a way disconnected from theoretical practice, describing herself as being "really laid back", in essence comfortable with what might be a lesser performance in class, and on the other

hand she sees her lack of preparation as something she works to improve by seeking out help from her professors. This lack of preparation, and this struggle with math and science are pretty substantial indicators of her identity. This idea of struggle seems to be a part of her identity and actually seems to help to push her forward. "I went from (laughs) like bein', like, a top student in high school to goin' (inaud) either average or below average here... a switch in my grading (laughs) was, like, a very negative thing for me." To go from success to struggle and in some cases failure can be pretty threatening to one's ego, but she seems to have remained strong and confident throughout the learning process. Going through this struggle from high school to college, the interviewer asks her what made her stay in the program and she replies "Um, jus' 'cause I knew that I w-, I was smart. Like, it wasn't like, "Okay, I can't do the work." It was jus'-, it was a challenge and I had to push myself a little bit more." That statement "I was smart" stands out, as she also seems to not believe that she can excel in some of these subjects or in theoretical practice, but still knows that she is intelligent. Therefore on some level she is unphased by these struggles and instead uses them to push forward. "I guess my determination as a student is a little bit above average. But um, I think I'm average in my schoolwork, (laughs). I think I'm pretty l-, average. But I'm a hard worker, so." The idea that she is determined and hardworking plays into her attainment, i.e. she might not be good at theoretical practice, but she is good at working hard and some of this hard work and determination is what defines one as a good engineer.

The other very interesting distinction that we start to see here is actually supported by the described experiences of the Trinidadian students whose stories we've already reviewed. The international students here referenced the strong preparation they felt they received in their courses back home. Roxanne on the other hand feels behind in comparison to the international students she sees around her that have had a great deal of preparation in high school. "As a student, well um I can say I'm a little bit behind because you know the

school I came from, from high school. I'm a little bit behind as far as the other students, cause they're mostly international and have like a their education level is much higher and so." This data point is all the more interesting because it sets up a possible division between groups of students in the way that they define their own identities."Well, like I said, they come with a background of knowledge and I didn't have like the best high school education I'd say, and most of them, already have jobs back at home. They're like Nigerian, and Trinidadian, it's like the most people. It's like a couple of us Americans but so we kinda are similar but yeah." This idea that she feels underprepared in comparison to a different group is important here as it applies to her understanding of her own identity, and we'll return to this distinction that she makes between herself and international students as we explore this aspect of her identity as well.

The beginning of one of Roxanne's interviews is very telling, 'everything's going good. Jus' stressful - that's Engineering." For many of the students in this analysis, they've accepted that this is normal, that engineering is a challenging field of study and they believe the level of stress and sleep deprivation they go through is the norm shared by all engineering students. It's as though many students come in knowing that there will be a cost, that they will have to sacrifice some part of their lives to make this career dream a reality. In reference to Roxanne just beginning her first year at UPri, "everything was surprising about my classes, because most people like come in here and say, "Oh you know your first year is like your thirteenth year of high school." But please like it's on a different caliber, it's a whole different, yeah." For Roxanne a great deal of this cost and this stress comes from her courses. "The most difficult thing is basically these math and science classes." We can see a pretty similar schedule for Roxanne that consists of little sleep, a great deal of study time and a number of extracurricular activities. "Mm, classes in the, like, morning-time. Then, like, meetings for different E-Board... Executive board – like, the president, or treasurer. So I get home pretty late 'cause I study after that. Then

my day ends at 1:00 or two o'clock. I get up like around 7:00." But it seems she also reached what she felt was almost a breaking point in her and her classmates' third year of school. "Junior year was the-, I almost dropped outta Engineer. First semester – the worst ever experience. Like, people were jus' like having breakdowns like i' the middle of the day..." And we see Roxanne's interpretation of the performance or investment of her professors is similar to a number of the other students in this analysis. "The workload an' like the teachers that we had jus' didn' care. Like, it was-, it was intense 'cause you would have a pile of homework, didn' understand it, and still had to take a test on it. So it was jus' stressful - workload and teachers who didn't teach. Yeah." The interviewer points out "so basically junior year people come in contact with teachers they've never had before?" and Roxanne explains yeah, 'cause you get into your major." So it seems that so much of this third year stress was also dependent on a large shift in the curriculum, as students entered higher level courses that were more difficult, and taught by teachers the students had not yet had exposure to or an understanding of. Additionally, a great deal of stress for Roxanne also seems to come from different aspects of how her identity is interpreted by others.

When asked how she identifies herself, and what role race and gender play in engineering Roxanne says "Mm, Black African-American… being a woman and being and African American you're kinda like if you know your stuff you kinda can just get the job type of thing cause they're looking for us. Cause there's so few of us out there." She distinguishes that experience of being a sought after commodity in the industry, from the experience of people that are not from underrepresented minority backgrounds.

> I feel that it's kinda like a given for some races like I—everyone—you know they don't have to um prove themselves in the field. It's kinda given like OK, they're taking this major as far as like minorities you can—well African American

> minorities I should say you kinda proving yourself. But every other race is pretty much, it's just a given.

This idea that she has to prove herself harkens back to the feelings of stereotype threat that many underrepresented minorities and women most likely experience in the engineering industry and its educational institutions (Steele, 1995). The interviewer goes on to ask, "OK. Are there any barriers or advantages or disadvantages, for you as a African American engineering student?" Roxanne replies, "Um it's advantages and disadvantages, first when you go into industry they looking at you like you don't know as much as them, so you kinda gotta prove yourself. And um advantages because it's more likely for you to get the job." This is such a conundrum to feel like you are sought after by companies, but can never relax into a position where you're not always having to prove yourself as you're being compared to the stereotypes that other engineers hold about you based on your race and gender. The interviewer delves further into Roxanne's experience related to her gender. "Do you think there is a major difference between the experiences of male and female engineer stu—students?" Roxanne replies,

> I definitely do, I definitely do because it's male dominated and we're in a classroom it's different cause you like in a classroom with like so many dudes and it's a couple girls so you mostly interacting with dudes and some dudes have this thing like you know I know what I'm doing, especially when you're building something like I know what I'm doing so they kinda try to push you to the back, but you gotta be real aggressive when you're a woman, yeah.

This track, of having to prove oneself sounds very challenging, and it seems to happen from the very beginning of Roxanne's path, starting at least as early as college and extending into her perception of what it will be like in the industry once she enters.

When the interviewer asks more specifically about Roxanne's gender in the school environment, "How's it being here for you, as a female engineering student?", Roxanne describes her interaction with male students that assume they are more capable and knowledgeable than she is.

> Well I experienced some dudes who thought you know they knew more than me just because I don't know they had that ego type of thing. But um for the most part I met, you know I got a lot of male friends so you know. That's how it is like you mostly surrounded by males here. But it's been good so far. This like one of the only majors that they what males ov—dominate?" "I think so...

Additionally, Roxanne served as the president of the Society of Women Engineers while at UPri. "And then like Society of Women Engineers you know it's so few of us girls here so we kinda bring them together and basically just you know common base, it's you know, the same thing, you know, bringing us together and uniting us thing." And it seems some of the stress of being a gender minority is allayed by building relationships with classmates and getting used to one another. "Here, um, I guess freshman year is the first part, an' you're tryin' to adjust to things, an' the guys come in jus' to work (inaud), you know, couple girls in the group. But for the most part, when you get to your next classes, like, you don't even-, since you're s' used to those people an' they're used to you, it kinda flows. Like, it's not as bad." Therefore it seems with time and some degree of coping, some of that stress is allayed for Roxanne.

As Roxanne finds her gender underrepresented in school, she also finds her race underrepresented in her co-op work.

> Oh, yeah! (laughs) Oh yeah, oh yeah. Oh yeah. Cause bein' on, like, co-ops-. I was on a co-op for 7 months an' was in Buffalo – predominantly white... An' it was outside Buffalo, too, so it was like predominantly White. All the Black people was three of us: two from [UPri], another person from another university... cause you're in the corporation with nothin' but White males who-, old White males, so they're jus' kinda like, "What is she know?" I did, like, about 3 internships too, so yeah.

Roxanne finds herself a gender minority at school and a racial minority in multiple workplaces and internships. While the realities of this underrepresentation seem extremely daunting, Roxanne seems to take much of the challenge in stride. In regard to race, she states

> Well, it jus', I was jus' able to um, not be naïve of it. Cause, you know, being here at [UPri] sometimes it's kinda like, "You're smart." And I'm from Detroit, so it's like you're surrounded by Black people all the time. So that jus' lets you know that it's out there. An' it g-, actually geared me up a little bit more to do even better than, like, the other people,so…

Realizing the realities of the learning environments and the work environments around her, instead pushed her to work even harder at her studies to become more competitive in these settings in hopes of allaying some of the stress involved with being discriminated against. The other side of this situation is the student perspective that there is a high demand for underrepresented minorities and women within engineering companies. For Roxanne this concept is translated to companies' recognition of her enrollment in a competitive HBCU like UPri. Roxanne refers to "advantages, like, the top companies

come to [UPri] ‘cause they feel-, since we’re a minority school, they feel that we’re the top o’ the top minority. So they come directly here.” Roxanne goes on to explain,

> you can’t get in engineering to get a job by being jus’ African-American. An’ this is (inaud) when you do get to those corporations you’re kinda shocked because it’s, like, all-White males. An’ bein’ a woman also, it’s kinda like you get some racist, you know, tendencies from a lotta people. So just adjusting to that, ‘cause although you get the job, jus’ kinda like, you still gotta stay on top o’ things, ‘cause they’re always looking at you.

In addition to the insights we find surrounding Roxanne’s racial and gender identity, she also shares another identity distinction. While she identifies as Black and African American, she sees a clear difference between her experience and the experience of students that could also be considered Black, but are also international students visiting from their home country to study at UPri. This begins in reference to one aspect of her experience at the school that she finds difficult, "Um for the most part, just adjusting to like—people who come from like different areas—cause I was like I guess you call it Midwest whatever, um cause you meet everybody at [UPri] like people from like Nigeria to California so that was biggest difference, because I’m used to being like around my Detroit people yeah." Here the interviewer asks, "was it a culture shock, coming here to [UPri]?" and she replies "It actually was I didn’t think it was, cause I thought, you know all these black people but it was definitely culture shock because you can live down south and be totally different from me. So it was different." Here Roxanne makes reference to being from Detroit, and finding the experience of Black people from other parts of the country and other parts of the world different, to the extent that it caused her some degree of culture shock. This applied to both students and faculty alike. In response to being asked if there was anything else surprising about classes she stated "Um interacting with

those professors who don't talk like you or you know clearly that was like one of the biggest things I guess." The interviewer asks, "were they like um they're from out of the United States?" and Roxanne replied, "Um, yeah so that was kinda difficult and like being from like the US you're kinda not used to like those accents like so you don't really take your time to listen to them so." The areas in which these cultural differences seemed to have the most impact, were the experiences and interpretations that Roxanne had that were also closely related to her feelings around her own personal identity. "Just adjusting to bein' in the class of, like, the elite of different countries. Like, I-, internationally think that has a (inaud) on us Americans." She begins here by referring to these countries as elite, and based on her earlier references to high school preparation, seems to feel that students from these countries have had much better primary education experiences than she has.

> Cause a lot of 'em are older than us 'n already were in the industry while we're jus' coming fresh outta high school, you know, on top. But these people are selected from their particular country, you know. And they're-, they be like 36 in the class, but they already... "Oh, my boss sent me here." We're like, "Oh, really?

Here we find that in Roxanne's experience, a number of the international students she has had classes with are also substantially older and more experienced than she is. "A lot of 'em already know or seen the stuff in high school or in the industry, so… It kinda makes you a little bit mad because you feel like you're kinda behind, like, on a lotta stuff." And this friction point for Roxanne seems to push on her assessment of her own identity. When we think back to her descriptions of being poorly prepared in school in Detroit, or we think of what appears to be her fixed mindset when it comes to her assessment of her math, science, and theory proficiency, we can see that she deems her abilities or her preparation to be lesser than the international students who she seems to

be surrounded by (Dweck, 2012). “So, I guess you’re kinda like, “Dang, am I slow or-..." So, I would say that you begin to realize how different, like, the different countries are. Because America, you don’t feel as prepared or as well-knowledged as the international students." Roxanne goes on to apply this interpretation to the work environments to which she’s been exposed: "Like, when you’re a-, another you know, nationality, it’s like you can just sit there and do one little thing that’s not as special but it’s, like, looked at as higher.” Roxanne begins to explain a hypothetical situation, seemingly based on her own experience, where an international student makes a small contribution and it’s met by an employer with very high regard, as though the standards for international students are lower, or they have a lower threshold to reach to solicit high regard for their performance.

> Like, you can actually-, say if a minority was doin’ the project, an’ you jus’ say, “Oh,” you know, “I feel that this should be placed here." Like, uh, say a resistor or somethin’ (inaud). But you thought o’ the whole idea as the minority, but since they jus’ put that special touch in (inaud), like, the boss comes around an’ you kinda maybe brushed off.

Roxanne qualifies this a bit by saying “Depends what type o’ company it is. But-, an’ they’re like, “Oh my gosh”, you know, “John, you know, you really thought o’ that?” An’ you’re kinda sittin’ like, “I just did this whole project." An’, you know, “all he did was do the finishin’ touches." Combined with Roxanne’s feelings about her lack of preparation or her struggles with math and science, are her feelings of being disregarded or passed over when it comes to performance in a work setting, and we’d assume that the work settings she’s referring to are either the co-op or her past internships. Thinking about the multiple identities that Roxanne embodies, being Black, a woman, and from a high school that she feels did not prepare her well for her current course of study, you can see that this distinction between domestic and international students for her is another

situation in which she feels she is either being discriminated against, or being given less of a chance to succeed than others. According to Roxanne's experience, international students are given far more preparation in primary school to be able to easily excel in classes, as well as granted higher regard for lesser impact at work, placing them even further ahead of Roxanne. Consider, for example, a moment when asked about her experience as a female student, when she states,

> Yeah. Definitely. First off, when you first come, you're used to like, you know... You're-, so you're like, "Okay, I'm a woman. I can do anything a man can do." But also, the ends of classes, guys-, I mean, they don't do it, like, on purpose (inaud), but your opinion sometimes doesn't count.'Cause they're like, "Okay, what does she know?" type thing. So I think your opinion is kinda like pushed back a little bit more or some o' the I guess, like, the hardware-type things – maybe you wanna build something – you're not seen as the person to do it type thing.

Taken as a whole, Roxanne has many parts of her identity that she feels are not well represented at UPri or in the industry jobs and experiences that she's completed.

Interest

Roxanne was drawn to engineering by her affinity for technology and gadgets. Her more hands on nature pulled her away from the computer science and programming focus. With the help of her co-op position, she knows that she enjoys working in industry much more than being in school. There is however some degree of conflicting ideas in her reasoning, as we also find that Roxanne ultimately wants to be a small business owner in a field other than engineering, specifically owning a jazz restaurant that will generate

income for her, allowing her to be more hands off in her career, and owning a business that she only needs to check in on from time to time. Also interesting on Roxanne's path is that by her junior year she gives up on pursuing classes that she is specifically interested in, instead choosing classes that she knows she can perform well in. Roxanne feels that she is strong on the practical, hands-on, applied side of engineering practice, but needs a bit of work on the theoretical side. Like the advice she gives to incoming students, she suggests that they expose themselves to engineering as early as possible so that they know what they are getting into, implying to some degree that she might regret having chosen her major, or there might at least be some disconnect between her interests and her current educational focus, at this point too late to remedy when it comes to her major.

Identity

Roxanne has more of a hands on nature, stating that she likes to be able to directly see what it is she is working on. However Roxanne feels grossly underprepared by her high school program in Detroit as she studies her field at UPri. She identifies as a student whose progress is behind that of others around her, especially when she compares herself to international students from the Caribbean that have had a great deal more preparation than she. She consistently identifies herself as a non-theoretical person, and rather as a practical or more application focused person. Roxanne recognizes that she is one of very few Black women in industry, and the co-op is a good example of where she's already had exposure to this reality. Additionally, she feels that people that pursue the engineering route are very dedicated and focused on what they are doing. Her example of her dedication is that she has found herself staying up the entire night just to complete one particular math problem. She feels that engineering students are able to handle that challenge and stress to a greater degree than others who are studying non-engineering

subjects. Roxanne also recognizes that engineering students can tend to be more isolating of themselves, as they limit forms of socializing, often working till the wee hours of the morning. Roxanne, however socializes with a lot of non-engineering students, and identifies herself as a social person and not isolated from others. She actually realizes that she needs to be able to learn with others in a social environment, as multiple different types of tutoring proved to be less useful to her than working in study groups seems to have been. Roxanne is a student that embodies a great degree of resilience, as even though she feels behind schedule and often finds herself struggling with coursework, she still states outright, 'I'm smart', and is able to get from challenge to challenge recognizing that she is highly capable. Overall, Roxanne sees herself as maybe an average performer when it comes to grades and studying, but knows she is a hard worker and very dedicated nonetheless.

Attainment

One of the interesting things about Roxanne's case is that she bucks the convention laid out by her professors that being proficient at engineering theory is what makes a good engineer. Instead Roxanne believes that a little bit of theoretical knowledge, coupled with a lot of practical hands-on knowledge, is what is needed to be a good engineer, as one knows how to apply theory to implementing or building. As Roxanne worked a co-op position for a year, she was given the opportunity to leave UPri for that time and actually work in the field of electrical engineering. This experience is significant because she seems to neither be interested in, nor feel proficient with engineering theory and the content that she feels professors mistakenly deem most important to being a good engineer. In addition, Roxanne believes that without her experience with the co-op and an additional internship position, the electrical engineering program would not have prepared her well enough to be a proficient electrical engineer.

Beyond this practical versus theoretical nature, Roxanne feels grossly underprepared by her high school program in Detroit, and substantially outmatched by international students that she views as having so much more experience than she does. While she sees herself as a doer, gaining practical experience and working on hands-on projects whenever she can, she feels that professors believe that if they 'push the books', and all the content surrounding theory, then one should end up being a pretty good engineer. And she also believes that instead of pushing theory, engineering professors should focus on covering how best to grow one's communication skills, because being a good engineer is very dependent on being able to effectively communicate with others. She uses this point to distinguish her own identity as a more sociable communicator as opposed to the theory-focused engineer that she believes her professors see as the ideal. Roxanne feels grossly underprepared for the engineering work that makes up her training, has little interest in it, but feels she is an adept communicator, something she sees as a facet of being a good engineer. Roxanne is definitely on the low side of attainment as she has little reason for pursuing engineering that is related to being the type of person who is an engineer, outside of communication, which can also be deemed as important for many other career tracks that don't require the level of effort that engineering will require of her.

Cost

It seems one of the major costs for Roxanne in pursuing a degree in engineering and ultimately a role as an engineer, is feeling outmatched and unprepared to the extent that she has to struggle in her courses to be able to perform and learn at the same level as the better prepared students. Cost for her is also about time lost, as she sees her non-engineering friends are able to go out and participate in the activities they enjoy. She notes getting invitations from her friends to participate in activities and trips, and her

inability to attend, emphasizing that she is missing that time and missing that opportunity to build and grow friendships, so this is a clear cost for her as she sees relationships that she values being hampered by the demands of engineering. The cost for Roxanne comes from the amount of time and effort that she has to devote to be competitive and successful in her courses. This is in diametric opposition to her quality of life, as she cannot make friends or build relationships with others. In essence, she cannot live a regular, emotionally balanced, supported life where she has the chance to build fruitful relationships with others to find happiness and fulfillment.

Utility

As noted earlier, the most prescient piece of Roxanne's story when it comes to her interpretation of the utility of an engineering degree and career, is that she believes engineering will afford her enough income as she rises up the corporate ladder to ultimately invest in a non-engineering business, her example being a jazz themed restaurant that she believes will ultimately allow her to do less work on a daily basis.

Myesha

Myesha is a Computer Engineering major from South Carolina that struggles with whether she should be pursuing her degree or a degree in language studies, as she feels that she had very poor math and science preparation during high school. She feels extremely challenged by her major courses, but actually feels a need to pursue a field that is challenging for her as opposed to something she already feels proficient in, like language studies.

In addition to these challenges, she wrestles with her strong interest in language and cultural studies, and how what she sees as a more practical degree in engineering could be coupled with language learning to eventually create a business that provides developing countries access to computers and technology. When asked to describe these future goals, she states, "I want to get my computer engineering degree here... I want to become a Rhodes Scholar and study at Oxford for two years..." Myesha would like to study at Oxford or an Ivy League university like Stanford after completing her degree in engineering. "If I can branch off, I'd like to go more into international relationship-, international relations, or something like that... that will give me an opportunity to work more in... not really engineering, but of computers, um, building computers, um, you know, what makes them work, you know how much is the cost of them, um, being built…" For Myesha, there is a conflict between something practical that provides utility, specifically through financial stability, versus studying something that might be less practical but something in which she finds the learning curve less steep. Myesha is looking for something like engineering that she can mix with international relations "to actually get a job where I can build myself up financially and skillfully."

In reference to her high school years, Myesha states, "Yeah, we moved every two years and-, I don't want to say it was lonely because I'm, I'm, I'm a pretty social person, you know, I'm really good at meeting new people." As it seems she moved from school to school, Myesha's identity in high school seems to have been at least in part defined by her focusing more on academics than on a social life and connections to friends, classmates and community. "And um, high school, it was, it was, um, a very, um, I don't want to say lonely experience, but it was a very diverse experience. I was able to meet a variety of people. I didn't get the whole, the whole social thing going. I was, um, I was always at a new school, always, you know, meeting new people. So that gave me a better opportunity to focus on my academics." While some of this lack of social interaction was

due to moving schools, it also seems that some of it might have been due to some degree of culture shock at one of those schools, "The large high school was predominantly white, the small high school was all black; it was one white person in that school. And so, going to [UPri] I'm, I'm used to being around a lot of um African-Americans, people of African descent." We'll return to some of her feelings about race later on in the narrative, as it seems some of these high school experiences might have had an effect on her feelings about her own racial identity.

As Myesha was only interviewed as a freshman and later lost to follow up, it seems that a lot of her story is focused on wrestling with whether or not she wanted to continue engineering. "I-, actually, um, when I came into college, I didn't know what I wanted to major in." The data from her struggle with this conundrum, although limited to one interview, is very extensively covered in one of the longest single interviews in the dataset. Her interest in the field was very strong, and over the course of the interview she displayed evidence about being very torn on the subject of whether or not to continue with the engineering degree. "Um, engineer-, I've always gone through life saying, "Oh, I want to be a computer programmer, or computer engineer," cause they-, [inaudible] sounded cool." In addition to this strong interest, it seems that she's been able to enroll in a large number of engineering courses in a short period of time, as we can see when the interviewer asks her to lay out her current classes, "Right now, um, Intro to Engineering, um, Intro to Engineering I and II, Calculus I and Calculus II, and programming, Intro to Programming."

In reference to UPri, Myesha states, "Um, I love the environment. I love, um, uh, just--the intellect here. Everybody's, everybody's, you know, I won't say everybody's so smart, but everybody's talented, everybody's driven, everybody's-, I, I, I love the environment. It's fun for me." When it comes to Myesha's more general experience at

UPri, she is very excited and sounds very fulfilled. "And um [UPri] was my dream from the get-go. It's always had a great reputation. My uncle went, he's successful in computer programming now. And so coming to [UPri] really, it was just like a dream come true." It seems also that having a family member (actually not just one, but two uncles) that studied computer science had a great deal of influence on encouraging her to explore the field at UPri. The interviewer states, "So you said your uncle was the computer programmer? Did he have any influence on you kind of learning the computer" and Myesha responds, "Yeah...I think he owns his own software company, yeah he was kind of my influence, cause I, I love my uncle... I like the way he interacts with people. I was like, "Well he went to [UPri]. He majored in computer science, so maybe I could be like him.""

The most challenging thing for Myesha seemed to be what she saw as a lack of preparation in math and science classes prior to entering college. She also ultimately finds that specific subgroups of international students at UPri actually have a great deal more experience.. "And and when I got here, I was like, "This is a lot of math and science and problem solving," and that's something that, it's not that I haven't been interested in, but I'm not very good at it." Myesha's level of attainment, recognizing the qualities that an engineer holds, or what an engineer is good at, and then relating to those qualities and feeling that she herself held them, seemed almost non-existent. She seemed to believe that engineers are defined by their abilities with math and science, as well as their abilities as problem solvers. She outright stated that she was not capable in any of those three areas. One of the reasons that Myesha's story is so compelling though, is that she held a genuine interest in engineering, and she states outright that she came to school to learn how to be good at problem solving and math, so that she could become an engineer. So while she does not immediately see herself as having the qualities that define a good engineer, she recognized something that researchers and students alike might be missing.

She recognized that one intention of attending a university and pursuing a field of study that one has little experience in, is to procure the qualities that a practitioner of that field possesses. She states this very clearly, "I'm not a problem solver. I am, that is m-, one of my greatest weaknesses, I mean, I, I don't do good at problem solving but that's why I'm here, I'm here to learn." She envisions becoming an engineer by virtue of her university training.

Myesha describes some of the troubles she found with her program early on, "And um, so as I got in the engineering, you know I started taking Calculus and I was like, "You know what, this stuff is hard! I don't like this." While she may hold interest in the application of engineering theory and concepts, she had trouble finding interest in her math courses especially because they were challenging for her. She describes reaching out for support and advice from her mother. "And uh my mom said, the only problem is m-, it's not, it's probably not that you don't like it, it's just that it's a challenge for you and so you're feeling discouraged, and you feel like you want to get out of there." This is not only a rich description of Myesha's experience, but significant when one thinks of the number of URM students that enter school with very little exposure to engineering, but who have a great deal of enthusiasm and interest around finding out what engineering is, and how they can develop the competencies for careers in the engineering field. The legitimacy of the choice made by students to pursue majors in college that they have very little prior experience in or knowledge of, seems to be an area of higher learning that's underemphasized in the current discourse. Myesha seems very excited about being that type of student, one that knows very little about engineering, but is intrigued about finding out more and pursuing a degree in the field. "But so, um, I stuck to it and ever since then, you know, it's been a challenge, but I like it because it's so intriguing. Every time I find something more about engineering, I like it even more. I just want to be a part of it."

Even with this high level of excitement for the field, it seems that Myesha has met her fair share of challenges in class work both at UPri and prior to UPri. Many of these challenges seem to center on test performance.: "I will study my behind off and fail the test. I don't think I'm studying right. Um, I've never been a good test taker, ever..." I didn't do good on the SAT, I, I do good in classes, but I don't do good on like standardized tests. I don't do good on, on tests in general, you know." Additionally, it sounds like there is a lot of variability in her performance in classes, sometimes finding herself doing well, but also having a great degree of worry over what sounds like an inconsistent performance. "I'll do homework, I'll get the work done, but if you actually try to test my knowledge, you won't, you know, you won't see, you know how this girl's been makin' A's throughout the class, and she can just fail the final or whatever." This inconsistency between her effort and her performance is something that causes her to self reflect a great deal, but unlike other interviewees in this analysis, she seems to almost exclusively internalize the problem, i.e. the fault does not lie in the design of the course curriculum or the execution of the course by its professors, instead she views the problem as due to something that she is doing wrong, that she just can't seem to get a bead on. "Um, and I don't know why that is. I'm still not sure yet. Um, but um I study, and I work hard and I acknowledge the fact that I'm not doing good on tests, so there's something wrong with the way I'm studying, so I do more time trying to evaluate the ways to study." And this is why it seems she does a lot of iterating on her process, so that she can find the thing that actually ends up working for her, and brings her success, "that's why I study so much, cause I'm just testing out new ways to study, so I can actually acquire the information and take tests better."

When it comes to Myesha's value of attainment, she describes problem solving as an important characteristic of an engineer. "A good problem solver... engineers and

scientists are good at problem solving. I mean, they take situations, they analyze them and they come up with a solution, you know, to prove something." Myesha goes on to explain that while she does not have this skill, she believes that acquiring it would make her an engineer. "So I think if you acquire that skill, um, in any aspect, I mean, and you could use it in, in any situation, I think that would definitely make you a engineer." However, Myesha's current assessment of her own skills is that she is lacking in problem-solving abilities, almost entirely. To what extent this is hypercritical or defeatist is hard to say, but from her own words, one can tell that she does not define herself yet as a problem solver, and therefore she does not yet see herself as an engineer.

> I have a problem, actually identifying the problem, okay. Um, and, and it starts like wi-, with just like regular word problems you know, that's already a problem solving um problem right there. And so, it takes me awhile to actually look at the problem, like, "Okay, so what are they asking for, what do they really need?" And so after you identify that, you know, you come up with a solution, and then that's just a whole nother thought process in itself and-- like I said, I don't like to think...

The interviewer takes this opportunity to explore what seem to some extent to be the contradictory answers which Myesha is sharing. She states here that she doesn't like to think, but in another line of questioning explains that she genuinely loves talking with people, debating points and questioning her assumptions. The interviewer pushes back, stating that this assertion contradicts her statement in support of her assessment of herself as a bad problem solver, by her own standards someone that does not like to think. Myesha makes a distinction here in stating, "I'll research things like probably that I like, like um in... I love the research on that. Um, uh, Portuguese, I love doing, I like doing things on, uh, researching like literal topics, um but it's a whole nother thing to try to go

back and research-- math and, and science and just those theories…" So we see that she's lacking some confidence in her ability to answer questions within the realm of math and science, and this might be what is hampering her and making her believe that she is not a good problem solver. She attaches the same positive statement to the end of this line of answers that she does during many other lines of questioning though, "I like the challenge of, of learning to learn it."

Although only early on her educational path at the time of this interview, she does appear to be standing at a major crossroads when it comes to finalizing her choice on the area of study that she would ultimately like to pursue. And her struggle here seems to be in figuring out if she actually enjoys math and science, two general areas that she views as the foundation of the discipline of engineering. She states,

> I don't like math and science but I'm not sure if I don't like because I'm not good at it or if I just really don't like it. Um, you know my mom wanted me to question that, she was like, "You know [Myesha] you know, you always say you don't like things when y-, they don't come easy to you," so I don't know if I, I'm just saying, I don't like math and science because it's not coming as easy as stuff like history and, and my own culture.

Myesha is clearly wrestling with whether it is her fear and struggle with the concepts that is tainting her overall interpretation of the engineering field, as opposed to genuinely not being interested in the subjects overall. At the same time, Myesha gets a huge rush from dealing with challenging concepts when she ultimately is able to figure out the right answer to the question she is trying to solve, "the success of, of conquering a math problem, like going home and actually understanding a calculus concept, is so much more rewarding than-- than me making a, a A on a Portuguese..." This rush seems to far

outweigh any success she finds on the alternative path of language studies. There is this mentality of teetering back and forth between the values of attainment and interest that we see in Myesha's description of her experience thus far at UPri. She seems to want to challenge herself, and her mother mirrors this want by pushing her further toward that challenge,

> I'm always crying, I always want to switch my major. I just don't know what-, I don't know, um, what would just keep me-, cause m-, my mom says, she said if I don't do anything that's gonna keep me thinking and keep me challenging and keep me, challenged and keep me moving, she says I'll fall off and I just go and I get in all that kind of stuff. And I want to try to avoid that.

This family guidance from Myesha's mother is very interesting because it references her wanting Myesha to push herself into a zone of discomfort in her learning, to keep her challenged. Additionally, it's a suggestion from her mother that she keep herself busy so that she does not revert to an alternative path that seems to have some vaguely negative connotations attached to it. In this instance, attainment becomes a broader idea of Myesha challenging herself to have the characteristics of an engineer, so that she can ultimately become one and avoid an either less successful or in some way deleterious path. Either way, we also see that the quality of pushing oneself into a space that is less comfortable, seems a progressive goal for Myesha to hold, should she follow her mother's advice. This exploration of her attainment swings back to the area of interest, as the conversation goes to alternative majors that could be equally as challenging for Myesha:

> I know there's so many other challenging majors, but they don't, they don't intrigue me like, like engineering does. I don't like, I don't like calculus and physics and all this stuff but I like to see when people um, you know, build cars

> and they build computers, I like that part of it. I don't like getting to it, or like that. But I, I like programming and all that stuff.

We see here that Myesha also has a genuine interest in the applications of the concepts employed by engineers. So it appears that it's not just a challenging major that Myesha needs to make her happy, it's the combination of that challenge, with a true interest in the subject matter and its applications. She further characterizes the struggle that she seems to be going through day by day with this major choice.

> I wish I didn't always have to question why I'm in engineering and I, um, cause I do question it a lot....I wish I would've came in with another mentality instead of, you know... come into, to engineering cause it's cool, come in as it's just something that I want to do instead of coming in like, "Okay, I think I want to do this, let me just work, and see." I, I wish I would've come in with more clarification of what I really want to do.

This declaration reveals that Myesha feels she would be better fulfilled if she had come into UPri with a clear and definite choice already made about her future career, without the nagging doubts that she continually tests, by reflecting on her experiences with engineering. When she thinks about her long term goals as well, starting a business to provide computers to developing countries, she wonders how necessary a degree in engineering actually is. "As far as my long-term goals are concerned, that's what I want to do. Um, I-, is engineering gonna help me with that?... It's just all these, all these little--just thoughts, I mean, is this right, is this wrong, um, go through my mind." And Myesha seems to have already asked for advice from a multitude of parties, including family and additional advisors in student services, but it seems to not help. "I talked the lady in student services and a lot of people say the same thing, you know, "You should do what

you like..." I talked to my father... both my uncles who earned, earned engineering degrees... talked to, to my advisor but he wasn't, he wasn't very helpful..." Additionally, Myesha's conundrum here seems to be not just one of finding a field that challenges her to the extent that she wants to be challenged.

She considers additional advice she'd gotten to major in one specific area and then "like, you could declare another major a minor, in like political science or something like that." Here Myesha explains "I don't like politics and like there's, there's definitely stuff that I know I don't like, like I don't like politics, it's not challenging, I just don't like it." However, when Myesha goes on to explain how she feels about possibly majoring in art, she falters for a moment, "Um, I know I don't like the arts. Oh, actually, another contradiction in myself. [pauses] Cause it's not that I don't like the arts, I'm just not good at it." So it seems there are other areas that she enjoys or she is interested in, similar to some of the facets of engineering, but just like engineering she feels that she is not good at that field. As she describes how hard a decision this is to make, continuing to major in engineering or changing direction, she shares a very significant insight in her existential reflections about her career future. Myesha states outright, "I know I'm not gonna be an engineer, I know that. And so, um, why study engineering? Why get this degree? Um, why work so hard at something you don't even know if you like it because it's so hard or if you, if you don't like it cause you're just really, just truly do not like it um, why all the hassle..." While she states a few different jobs she could imagine herself doing, running a business to provide technology to developing countries, working in international relations etc., when it comes to actually practicing engineering, she states "I know I'm not gonna be an engineer." Is this a defeatist statement, and is it accurate? Is the stress of thinking about this branch point in her educational career too much for her to bear? Is it too stressful for her to envision herself as an engineer, or is she genuinely unable to see

herself ending up in a career in engineering? It's very hard to tell from her statements in the interview data.

Insights around specific student strategies for success at UPri have come up for many of the interviewees in this analysis, and such strategies also play a big part in Myesha's experience. She clearly tries to find balance in her course load from semester to semester. "Try not taking hard courses... too hard at the same time... when I first came here I was trying not to take a math and a science at the same time um, because those are my two weakest subjects, and I didn't want to have to struggle with both of em at the same time." Additionally, as she progresses to higher level courses, she finds this balance is harder to maintain: "But as I get more into the program, I can't avoid it, and... I am actually taking two major engineering courses right now, and, I mean it's, it's a challenge, it's hard but I have to, you know, I have to keep doing that." In these instances where courses cannot be spread out from semester to semester, it seems that her most recent solution was to continue her studies into summer semester: "if I look and I see that I'll be taking too many just hard, hard courses um I try to, uh, throw one of them in for the summer. Like I'm taking Phys-, Physics... I'm gonna try to take Elementary Data Structures over the summer, just because people have said they're-, they're not challenging, they're just time consuming."

Like many of the other interviewees, Myesha also focuses on which specific professors to take courses from: "Oh um, um, I definitely look for professors." The interviewer asks, "And how do you know which ones that you wanna pick?" Myesha replies, "Um, upperclassmen, upperclassmen, yeah." Myesha shares an example of how she accesses this upperclassmen data source. "Yeah, juniors and seniors. When, like I was there studying in the lab, I was like, you know, "[Carl], who do I take for Calculus III," and he was like, "This teacher's good, this teacher will give you A, but you won't learn, this

teacher you'll learn, but you probably won't get a A." They're really helpful in that aspect. They even made a good teacher/bad teacher list." Myesha takes this assessment of courses a step further than other interviewees, as she both weighs her ability to perform well in the class, and considers her ability to learn the content from the class depending on what professor she is taking. This strategy seems very much aligned with a more long term plan to find success both in the program and the field of engineering. Myesha wants to be able to understand, learn, and retain the information she learns from class to class as best she can, and choosing particular professors so that she can reach this goal, seems as important as choosing professors that will allow her to achieve a competitive grade. "Generally people think that if you can get a A, it's a good teacher. But through this semester, I have learned differently. Last semester, I received an A in Cal I, but I did not learn a thing, it's, that's why I'm struggling in Calculus II now." She shares an alternative example within the same class sequence, where it is clearly more important to her to internalize the content of the class than it is to get a competitive grade. "My Calculus II teacher, there is probably no possible way I can make an A in that class, right now, but I have learned so much from his class. And I can retain that information." Here we see yet another example of classes that a student at UPri feels are unpassable as well, due to the ways in which the professor has set up the course curriculum, "there's teachers like, like I heard... and you can't pass a [inaudible] or learn anything. So I would have to go with that teacher who will prepare you for the next step, even if you can't make a good grade." Myesha brings these ideas back to what seems to be one of her most fundamental educational goals, being able to truly understand engineering concepts, rather than simply achieve an impressive grade point average. "I'd like to make a good grade, but I don't want to come out of engineering with a 3.8 or a 3.5... and not know anything about anything. I messed that up in high school, I-, I've always been good at making A's, I can make a A, but that doesn't mean I'll learn it. So."

Interestingly, Myesha also engages with the field of engineering because of its utility. While she also has a strong interest in studying language and culture, she does not see those fields as very practical or lucrative. Myesha references the fact that her boyfriend, a non-UPri student is studying biology but is experiencing similar woes, "I like talking to him cause we're in the same situation. He's, his love is art, but he-, like he said, he wants something more practical too. And my love is languages and culture, and I wanted something more practical." To this end, Myesha shares that her boyfriend is studying Biology, and the two of them share their feelings with one another around what they see as a parallel struggle with pursuing practical, more specifically, lucrative majors while they have interests in alternative fields, "he just says, "I'll be a doctor and you'll be a engineer, think about, you know, how much money we'll make." That's what he always says to me." Additionally it seems that Myesha's advisor references the utility of a degree in engineering as well. "He, he was just like, you know, stay in engineering for the money. And I was like, "I'm really not really focused on the money thing right now." Um-- but then again money would help me with my long term goal so."

Myesha talks further about the utility of a degree program in engineering as opposed to a degree program in language studies. "I talked to a lot of interpreters and a lot of translators, and you know they're like, "Listen, the languages aren't gonna get you there. I mean, minor in language, find a way to study language, but get something that's really gonna, like help for fall back on, so something more practical." And it seems that Myesha's goal is actually to create a business and by her own assessment, combined with the interpreters' and translators' assessment in advising her, the utility of engineering is more attractive to her than the utility of language studies—"I'm actually gonna be starting a business so, I know for my long term goal, I'm gonna need to be financially stable." At the same time, she recognizes the value of the learning that she can attain from pursuing language studies:

> it's critical um before I reach my business... I actually want to advertise for a, a computer company internationally. Um, like sell out products with new in-, innovations are made, you know, I wanted to, to make sure our innovations are, you know, distributed around the world, and you know, that might take language skills, that might take knowledge of culture, and stuff. And understanding.

In addition to the perception that studies of language and culture offer less utility for a future career, she does not feel challenged by these fields, and being challenged by what she studies is very important for her, so much so that she uses this need for a challenge to describe one aspect of both her own and her family's definition of Myesha's identity. "Um, I didn't think a lang-, majoring in a language would be as rigorous as engineering and um, like I said, I always need a challenge, I always need something to keep me on my feet, to keep me thinking." And this is the way she looks at language and cultural studies—she sees them as fields that do not provide a challenge, whereas engineering does. "I like the way engineering makes me think. I don't think, um, learning a language would, would, I'm already good at learning languages." She juxtaposes language studies and engineering to show that the latter is actually challenging her. "I'm good at picking up languages, so why not major in something that's actually gonna test my skills? Um, test my character, you know, make me improve in something else rather than just languages."

While Myesha is a freshman, she is not experiencing the same level of challenge from upper division engineering classes that our other interviewees describe. However one would expect her to be dealing with a high level of stress as she describes herself as being very inexperienced at math and science classes, and lower division classes can be challenging for students with little preparation in place from high school. However, it

seems that this far along on her journey, Myesha has uncovered a solution to some of the stress that these courses could have created for her. She describes a plan that she found out about during a conference "I, I actually learned about it from a seminar at, um, um, a National Society of Black Engineering conference…" Myesha explains that the seminar is shared nationally, and she describes some of the tools she's implemented from it. "I'm on this Academic 4.0 Plan, and so it's a whole different schedule... It actually teaches you to relieve stress by not putting so much focus on just studying, studying, studying, but actually helps you organize your day... but you're doing other things that are stress-relieving... Where you're not studying so much that it's just nerve-wracking."

Myesha goes on to describe what her study practice currently looks like, "usually I would go and I would study until like 2:00 in the morning, and I would have a 8:00 class, so I wouldn't be getting enough sleep…." As it seems that she has applied this Academic 4.0 Plan to her practice, she describes the areas of study that continue to be taxing for her, and how she applies some of the plan's tools to solve her stress and make her study practice more efficient.

> I'm having trouble with calculus and instead of... putting in like three or four hours of just studying calculus, I'm actually learning to understand the concepts by... paying attention in class, that's, people should know to do, but they just don't... then going back and reviewing the notes so that I'm actually understanding... Talking to my teacher about it... actually helping you learn the information so you don't have to spend so much of your, your away time you know trying to go back and grasp all this stuff that you could've got from the beginning.

The plan seems to have worked well for her up till this point, as she explains: "I'd only been on it for like four days, but this is the first time that I have completed a whole calculus assignment and understood, the first time. So I'm already seeing improvements and stuff." Myesha is also very self reflective about her learning process, making multiple statements about her assessment of what type of learning style she has. She shares one example of this in an interaction with one of her professors. She seems to have no problem frequenting office hours and asking for help, and this seems to help her recognize what works and does not work for her: "And then I started going into his office hours and it's like, "Look Dr. [Smith], you know, I need you to show me... why I'm using this formula. Um, how do I use it?..." and he started doing examples and off the bat, he started actually doing examples in class instead of just giving us a formula. And that's when I started understanding, picking up some."

Myesha shares a theme also shared by other interviewees in this analysis, and that's the theme of *taking control of one's own learning*. "I don't go to tutoring anymore, I used to go to tutoring. But um my math teacher suggested that I just sit down and, and think about the problem instead of being so quick to run to somebody for help. And that's helped me improve." According to Myesha, that particular professor shares his assessment of Myesha's learning practice and it's included here as it's something that resonated with Myesha as she reflected on how she regularly would go about her work. "He says, he says, 'Now you're very bright, you just don't like to think.' And it's like, 'Got that right.'"

Part of Myesha's description of her own identity is focused on the importance of communication. She references both challenges that she's had as well as her appreciation of the growth she's been able to achieve by working through these communication challenges:

> A lot of the problems I had is debating with people here. I mean everybody just, I know everybody has their own opinion, but everybody-, everything is like, um, a debate with somebody, you know, you say something and somebody's always ready to attack you. And, in a way I kind of like it because you know it makes you, it, it makes you-, so I guess that wasn't even a bad thing, huh? Cause I like it.

On the one hand, Myesha notes that a good part of her experience at UPri has been due to easy communication, "a lot of people here, I noticed, are--kind of like me, you know they come from, um, a background similar to mine. And so it's been really easy to communicate and talk with people here." Alternatively, when asked what has been difficult for Myesha at UPri she also highlights communication by stating, "Um, talking to people... They call me Bubbles, I just say what I think, everything I say just pops in my head, so." As she further describes some of the opinions she likes to share, we get a clearer picture of how her thinking and her learning process work. When it comes to some of the topics or content she discusses with others she states, "I usually, uh, debate um African-American culture and history, um, because it's something I've been raised, and I knew about... different aspects like, um, the use of the N-word, um, um, African-Americans' current status in the United States…" Firstly, it's interesting here that she is having conversations around an area that seems to play a large role in her own definition of her identity, and secondly even more interesting is the fact that this debating and discussing of topics is also the way that she challenges her own understanding and her own knowledge of some of these concepts. "I like the fact that they make me go back and do research... I like to question things. So I, it makes me go back and question myself, you know it makes me like to think and like to learn more so." This last statement is significant because although she does not at any point state that researching topics, questioning assumptions, and generating more data about these topics, are practices of a

good engineer, I would argue that these are clearly qualities of a good scientist or engineer. While she may not see that she has qualities aligned with a high level of attainment to becoming an engineer, I would argue that welcoming dissent, testing one's assumptions, and generating data to support or refute those assumptions, define a large part of what engineers in multiple specialties actually do on a daily basis.

We do, however, begin to see where some of her hard work as an engineering student intersects with both her identity and the cost associated with pursuing a degree in engineering, as Myesha distinguishes engineering majors from non-engineering majors in stating: "I think we're under more pressure to-, not under more pressure-, I think, I think you just study more, science and math and engineering majors just really have to put in a lot more time studying." Myesha uses anecdotal evidence to support this idea that engineers, for the most part, are not social, "I don't see a lot of engineers in fraternities, in sports, I mean, it was like two or three, uh, engineers on the football team, um, one engineer on the cheerleading squad, and she quit." Beyond the examples she shares about particular individuals, she also explains that on the whole, she does not see engineers outside in the common area of campus, where most students congregate, "um outside of engineering, and um, you don't see them on the yard as much..." She also distinguishes the experiences of her roomate, a non-engineering major, from her own experiences and describes her consternation around the responsibilities that she feels are unique to engineering majors. "I always get jealous sometimes cause she's always talking about doing this and this and that, it's like, "Ah, I wish I could do this and this and that. But I know I have to go study for this test so, I know I have to, to you know, actually try to pick up this concept." Myesha pulls this point into a statement about the identity of engineering students, and how it is often defined as a non-social identity. "I think we are under more pressure to, to actually study more, and that's why I don't feel engineers are very social or as, more involved." And Myesha emphasizes the idea that she does not

want to ultimately fall into this category of a non-social engineer that has a life dominated by study and practice. "I mean you can, I'm trying to make myself a more well-rounded engineer, I just don't want to be the engineer that's like "Math and science, this is it!" You know, I've been wanting to, to broaden, you know, my horizons or whatever, but I think there is a difference." Myesha ties this back to herself by explaining that although she wants to be what she describes as more well rounded, she actually does not see herself as very social either: "I've never been the social butterfly. I mean I, I associate with a lot of people, but I've never been... I won't just hang out on the yard." It becomes clear that Myesha tries to be very organized not just in her school work, but also in organizing her past times too, to the point that she actually plans out her socializing time. "I don't just sit down and socialize, I actually plan on a time where you know it's sufficient for me to interact with different people." This mentality seems to both fit the engineering stereotype she has richly described above, while also showing that she applies time management and organizational skills to creating the space for downtime and social support that most students need. This is further supported as she describes herself as falling somewhere toward the academic versus the social side of the spectrum, "I like to party, I like to have a good time, but I don't mind sacrificing my party time to, um, to get work done. I don't mind at all. It's not like I have to have social time, uh...I stray more, a little more toward academic."

When it comes to the values of interest and attainment, Myesha has a variety of interests that seem to place her in a more non-traditional category of attainment. To be more specific, Myesha has some long-term goals that connect both her interests in language and engineering. In reference to taking Portuguese and Japanese, Myesha explains "I want to learn, you know, um, engineering from a different cultural perspective." She draws this into her future career plans, "And then my actually long-term goal is to, um, find the means of making, building computers on, for a cheaper price so that, you know,

we can distribute them, for a cheaper price, to developing countries." The earlier example I have used for attainment is also pertinent here: 'engineers are good problem solvers, I am a good problem solver, therefore I would make a good engineer' applies here, but in a different way. It seems that Myesha has a strong interest in learning about other cultures. She cites a very universal need for developing countries—a need for access to technology—more specifically in her example, physical access to computers. Myesha sees a need, and wants to learn about computers so that she can build out solutions that will solve this problem and need.

One of the most significant insights from Myesha's story is found at the intersection of interest and identity, specifically in the way that she struggles to better understand her interest in the field of engineering and how that also ties in with her image of herself, even more specifically her image of herself as a poorly-prepared, unsuccessful engineering student, when compared to a subgroup of students at UPri—international students from the Caribbean. In reference to what parts of UPri have been difficult for Myesha, she states "problem solving, um, math. I haven't had the pre-exposure that a lot of the other students have had and so I really do feel slow. I feel really stupid in class." As she'd referenced earlier, she feels that her South Carolina high school did not prepare her for the more complex and challenging level of math and science that she is now facing at UPri. And Myesha distinguishes this U.S. educational system preparation from what she sees Black international students entering UPri with. "That's been my main challenge, is trying to get up the pace with everybody else who have had this great pre-exposure, that've studied in, uh, like the people from the Caribbeans you know, I know they have a really good program there and so they come here and it's just like easy." Myesha gives strong criticism to the school system she graduated from back home, but she transfers the lack of knowledge the school system holds onto herself as well. "And for me, you know, not only have-, I mean I, South Carolina has one of the worst

education systems [inaudible] and I was basically brought up in that education system and I'm not, I've never been good at math or science." She describes herself as being at this very low level of understanding for math and science and lays out how challenging that makes it to pursue engineering, "And so to, to come into a, a, you know, major where that's the base of it, math and science is, is just killing me..." Additionally she compares her performance level in these courses in high school to her performance at UPri. When it comes to Myesha's assessment of her math and science abilities she states,

> I, I thought I was good until I got here... a lot of people base their abilities on grades and I'd been making A's, A's and B's in math and science, and then you get here and it's like, they really want to see how much you know. And it's like, "Well, gosh, I got a A or a B, but I don't know this stuff." So um, that's been one of my biggest challenges.

There are multiple facets of Myesha's self criticism here. Myesha clearly sees herself as unprepared and at a lower level of performance when compared to students at UPri in general, and also when compared to a subgroup of international students.

Getting some insight into Myesha's identity when it comes to race and ethnicity, we see that she identifies herself as African American. Additionally, when the interviewer asks what Myesha is looking forward to at UPri, Myesha responds,

> The opportunity... to be around people, from like the same culture who, who look like me. I wouldn't say look like me, but that I feel that I could relate more to, because in, I'm not gonna lie. Going to predominantly white schools has made me feel like I really can't talk to people because I'm-, okay I'm not pro-black, but I'm really sensitive about my race and so just being around people who understand a

lot of the struggles African-Americans go through is, is really fulfilling here, and that kind of keeps me grounded...

So Myesha points out that she is sensitive about her race, due to some past experiences at a predominantly white high school. She also explains that part of why she is happy to be at UPri is the opportunity to be around others who understand the struggles African Americans go through. Myesha notes that she might be interested in studying international relations at an Ivy League school after attending UPri, and notes, "if I could get that, um, that emotional strengthening here, then I know I'll be better off going to, you know, an Ivy League school, I'm more comfortable with myself. And that way, it wouldn't, I wouldn't, you know, be so-- ready to jump on somebody who says something about my [race?]." The interviewer asks Myesha at this point, if they were not both of the same race, would she answer the same way and she replies, "I probably wouldn't be as honest... I don't trust a lot of, uh, people that are not of my race with my feelings, because I don't think that they understand, and so I'm more likely to be more honest with somebody, you know, of my race." So race is revealed in Myesha's words as playing an important role in her identity. Additionally, she identifies as a member of a minority subgroup among the UPri population, "I think that the, that um African population is very large, the Caribbean population is very large. The American population is very small." It also seems as though there is some inculcation within these different subgroups, "you usually see, um, people branch off in the-, you know, their different areas. You know Caribbeans with Caribbeans, Africans with Africans, African-Americans with African-American." Myesha speaks to what she sees as the negative aspects of some of this separation of subgroups at UPri, "I know there's a lot of, um... tension a lot of times. I know, um, a lot of African-Americans feel that, you know I had this one girl came to me and she was like, "I'm tired of, of the Trinidadians coming in and taking all our money," and stuff, I mean just a, some negative aspects…" At the same time she notes the positive

aspects of this diversity within the school, especially the opportunities it affords her, "and then you hear from a different perspective, you know, “I love the way they come in here, and you know, they want to get a-, a, a education with us, and they’re willing to teach us, you know what they know, and help us,” so it’s just different perspectives coming from different people."

The flip side of this for Myesha, is the feelings she analyzes when she thinks of the difference between her preparation in high school and the preparation brought to college by some members of these international subgroups.

> I admit that I get, at times, envious of them because you know they don’t have to, to work as hard, you know, as I do. Um, because they’ve had a lot-, because I ask them, you know, “Hey, you know, you’re a freshman just like me, and how do you know all this?” And so, and you know, they’re like, “Well we have to go through two years of quote-unquote college,” before they come here, and [inaudible] and you know what, sometimes I think, “Gosh, that’s not fair.

Myesha seems to be playing devil’s advocate as she explores these feelings, consistently pairing a positive interpretation with what might be viewed as a negative one. "But I think again, well, I mean that’s good, I mean they’re learning just like you are, um, and you can learn a lot from them, you know. They have more knowledge so, why not, why not channel that and just and you know get what they know, too." The problem with her argument above—about channeling their knowledge—is that in practice it does not seem to have worked very well for her. Myesha shares a bit more about some of the barriers between her and these groups of international students.

> I feel, I feel like a outcast when I try to study with them, and I feel that they're so much more advanced than I do-, and I try, I mean when I need help with, with things like listen can you help me, but as far as study groups are concerned, you know, they do kinda form their own study groups amongst theirselves, and I don't get really the opportunity to jump into those… But if I can find one person, you know, that I see is doing good in class, I'm like, "Listen can you help me?" You know I try to, to work with them.

Myesha goes on to describe her theories for why these groups of international students might have become inaccessible to her, and her classmates with a shared or similar background.

> I think it's more of the level of, um, of-, well not even knowledge, just culture. I mean you know when you get in study groups sometimes you really, you don't always study. You know, you, you talk about different things, right? And so, you know, they branch off and they talk about, you know, their culture and then, when you hear people talking about their culture, you know, a lot of people don't just stop and think, "Well you know it's a different culture, you don't really listen to it." They, some people get offended and, and some people start comparing cultures and things. And so I think that's why, we-, at, at times we're not able to, to interact like we want to because you know, you get our culture and you know, they become debates and things like that.

What we see here is Myesha experiencing some degree of feeling inferior in knowledge and in performance, when she compares herself to the subgroups of international students that, from her assessment, appear to be the majority at UPri. When we think back to her references to being at a predominantly white high school, and her strong feelings about

race and the history of her culture, we see that Myesha (although there is no direct evidence provided in her interviews) is a prime candidate for possibly having felt stereotype threat at her high school when it came to performance (Steele, 1995). Alternatively maybe this wasn't the case, as it seems she also achieved competitive grades there. Is it also possible that Myesha might be experiencing stereotype threat when it comes to her international classmates? There is clearly, no white majority at UPri as it is a HBCU, but by Myesha's assessment, it is definitely a Black international student majority school. As Myesha equates these subgroups with being more well prepared by their secondary schools, it is worth reflecting on what effect this pattern might have had on her and other students with a similar Black or African American background.

In addition to race and ethnic identities, gender seems to play a big role in Myesha's understanding of her identity and the climate at UPri. When first starting school, she found it challenging to equate the large number of women on campus, with their noticeable absence in the engineering department.

> I would see like hundreds and hundreds of females on the yard and around campus, and you walk into the engineering building, they just disappear and that was a shock. I knew that it was, um,-- you know a male-based major, but I didn't know that it was so drastically large, I mean, there's hardly any females… And so that was-, that came as quite a shock, especially just because there are so many females here on this campus, and so little in engineering.

Myesha goes on to break down the numbers of women she sees in engineering on a case by case basis, "there are two out of, I think, eight students, there are two girls in my calcu-, in all my major, um, in all my engineering classes, compared to my um generic classes there are predominantly more guys in there." Myesha then compares that to what

she sees outside of the engineering department. "There are, um, in my programming class, there's about four or five girls out of like 25 students. I mean, it's really a shock but then I go to my English class, it's like, four guys out of like 30... but with engineering I usually tend to see more guys." Although Myesha sees such a small number of women in her department, she believes that is does not substantially affect communication around work between these two genders. "I haven't really seen the whole thing where females tend to stick together and males tend to stick together… I think we've all accepted each oth-, well not accepted, but we all have that commonality of engineering, and so I haven't seen a lot of discrimination, and I thought that was really good." She sees some variation in the way that men act and communicate with her as well, but it does not seem to affect her engineering process per se. "Um, you know, a lot of guys are really supportive, um, they don't try to put me down because I'm a female. Um, some guys say derogatory things, but I mean, you'll find that everywhere. Um, but it's not like, it's not like so-- uh, so noticeable that, that it becomes an issue. So."

Interest

Myesha actually has a very strong interest in language and cultural studies, and this interest seems to be in direct conflict with her interests in engineering. She explains that she hopes to be able to meld these humanities-based interests with engineering to create a future company or use this combination of skills to work in international relations. However Myesha does note that since childhood she always felt that being a computer programmer or an engineer sounded "cool." When we look at how her interests in the humanities compete with her interests in engineering, her descriptions of why she is following the engineering track seem a bit lackluster in comparison to her pursuit of language studies. This might in fact be due to fact that she seems to have more experience with language and cultural studies than she does with engineering.

Alternatively, it might be the case that Myesha has just the beginnings of a plan for working in the field of engineering, and as she pushes forward in her studies will find more clarity on how to conceptualize ways she might implement the engineering skills she is building upon to then create her version of a company or career that embodies the two fields. She is however, in a state of questioning if she actually enjoys math and science. She struggles with this choice as she is worried that she cannot interpret her feelings clearly due to engineering being such a new field for her that she has little experience in it. Overall, Myesha wonders if she sticks it out on this engineering path, if she will ultimately find that she enjoys engineering work. The other facet of her experience here is that she is intrigued by the challenge of exploring what is a new, and so far unknown to her in engineering. It seems that a big part of her interest in engineering lies in the challenge of learning something new and complex that she has not yet proved herself to be adept at. But Myesha welcomes and actually seems excited about exploring this challenge, and this plays a big role in why she is interested in the field of engineering. I'd therefore summarize her interest as middling.

Identity

When it comes to engineering, Myesha identifies herself as a bad test taker, with little preparation in math and science, and it seems that she is actively trying to iterate on her study strategies, but cannot seem to find what she might be doing wrong, as her studying seems to ultimately lead to her poor performance in her engineering classes. Another important facet of Myesha's identity is that she characterizes herself as an outgoing person that speaks her mind without a filter, which tends to regularly get her into what sound like somewhat heated debates with classmates and colleagues. Additionally, she identifies with having to be a hard worker in engineering as she sees engineering majors as being under more pressure to work than other fields of study. Additionally Myesha

notes that she does not seem to find the people she considers to be more sociable pursuing engineering degrees. To that end, she references one person she knows that she viewed as outgoing and personable, that decided to leave the engineering track all together.

Myesha has a need to be more sociable at UPri as it seems to be an important part of her identity, and she works to find a way to systematically inject social time into her schedule. Here we see Myesha using what might be considered an engineering skill to solve the challenge of being sociable, for example making efforts to input social time into the system of her daily schedule at UPri. More significant is the fact that Myesha actually feels very "stupid" in some of her classes, and feels outmatched by international students from the Caribbean that have had much better preparation, and more experience with math and science before coming in to UPri. Additionally it seems that Myesha transfers her struggles with math onto herself, rather than displacing the problem onto the structure of her program or the lectures given by her professors. Myesha is internalizing her struggles entirely, and seeing them as something that is wrong with her that she needs to fix, rather than accepting the possibility that there might be something wrong with the design and pedagogy of the classes in which she is struggling. And the last major point about Myesha's identity is that she is very regretful that she did not enter UPri with a well laid out, decided upon, plan for the degree and career that she wanted to pursue. This still being called to question seems to make it very challenging for her to decide on a path, and choose that path's identity, to embrace or leverage for her continued growth at the university.

Attainment

Myesha relates that she's actually not good at problem solving, math or science, and she also recognizes that these are qualities and skills that engineers tend to hold. There's a challenge in attainment here as she came from a high school in which she was pulling down As and Bs, which are very good grades, but she was then dropped into an environment in which she found herself struggling to to find success in college. What's most interesting is that while she recognizes that she does not feel skilled in these areas, she notes that that is why she came to college, in effect to learn about and attain those skills, as that is what she views college is for—learning about something that you are not already good at.

Myesha struggles to understand whether her discouragement in these areas is just due to the fact that engineering is new to her, and she's having trouble getting up to speed, or if she is instead on the wrong path, and should instead pursue something that she is both good at and interested in, like language studies. Myesha breaks down the facets of problem solving to show the many ways that she feels she is bad at it, even at the first step of interpreting the words given on a test or an assignment to plainly identify what the problem actually is, and where to begin solving it. This helps us understand her level of attainment, as Myesha, by her own standards, does not seem to have the traditional qualities that an engineer might, as defined by her professors. This makes Myesha's attainment seem low. However, she is challenging herself to actually learn those qualities and attain them as best she can, meaning we could alternatively rate her attainment level as high. Myesha's being one of the two students in this analysis that is lost to follow up research, leaves us wondering. Was she able to complete the degree, and was she able to attain the qualities that are associated with being an engineer?

Myesha describes her experience with the calculus course sequence. She wants to be sure she can successfully internalize the content covered in the courses, instead of solely worrying about her performance and the grade she achieves. In addition to this, Myesha goes back and forth about the challenge offered by something she is practiced in, language study, versus the challenge of something as new to her as engineering. In what ways might rising to a challenge be an attribute of an engineer, which one might relate to her ability to become an engineer? While a challenging course of study may be attributable to engineering and other subjects, it seems that this is the way that Myesha is engaging with her level of attainment for the field. She seeks out new and difficult challenges. An engineer does the same, and this might lend itself to the argument that she has the ability to be a great engineer, as this seeking out and rising to a challenge seems similar to the attribute of problem solving. Lastly, Myesha describes herself as outspoken and having a mentality to debate. While this is not traditionally associated with engineering, the idea of counter argument to present a diverse array of thoughts and interpretations, is clearly an important aspect of the engineering process, where one weighs tradeoffs, pros and cons, to features of designs. However, Myesha does not seem to connect communication with the attributes of a good engineer. While she might not currently rely on this aspect of her personality to anchor her to the engineering path, it might ultimately prove a useful tool if she can recognize it as such. Additionally if she continues to push herself to achieving the qualities of an engineer, then her attainment level would be high.

Cost

Myesha's description of cost starts with a description referenced by all other students in this analysis, and that is sleep deprivation. It's also clear that Myesha struggles with tests and class performance, and ultimately seems to connect poor secondary school

preparation and performance, to come to the conclusion that she might be ill suited for engineering. She internalizes the poor performance, and it seems that her perception is that she is the problem. She does not seem to question the way that her UPri engineering courses are designed and taught. Instead all the onus falls on her, as though it is entirely her fault that she is not learning at the same pace as other students, or succeeding in the field she's trying to pursue. We see her actively pursuing alternative study strategies like the *4.0 Plan* and others. Myesha is well aware of the fact that the field of engineering is a difficult one. To that end, she recognizes that she is going to need both structure and support in the way that she designs her daily life. She's actively searching for things that will help her reduce the pressure and the stress she has felt on this path thus far.

Utility

Myesha describes engineering as a more practical path for her education and career than language sciences is. She sees engineering providing utility for her, as a career in the field will help her make money in the future. Engineering is really about financial stability for her, and therefore she sees it as practical and useful. Lastly, Myesha sees an engineering career as a way to pursue a future career track, where she makes computers and technology more accessible to those in developing countries with little access. It seems that overall Myesha views engineering as a means to an end, that end being a career that is lucrative and/or helps others in need, so utility for her is high.

Rorke

Rorke is a Computer Engineering major from Abbington Pennsylvania that fell in love with computer hardware as a kid when a family friend that worked for NASA came over

one day, and showed him how to fix the family's personal computer. A big part of the reason Rorke chose to come to UPri was to pursue his specific major program, as he expected it to give him even more exposure to working with computer hardware.

Rorke was only interviewed as a freshman and later lost to follow up, and although his data set is limited to one interview, his path is very extensively covered in one of the longest single interviews in the overall dataset for this analysis. Rorke describes himself as a first year Computer Engineering student who went to Abbington High School, in Abbington Pennsylvania, a city about 10 minutes outside of Philadelphia. He explains, "it was a predominantly white school, um, but it had a sizeable African American population... it was a high achieving school, and uh as far as my class work and stuff, I was in, um, mostly honors courses and stuff of that nature." He describes his time there, "Um, yeah I was very active, very social... I ran track, played football, ...like I was in twelve clubs and I had like presidency in two or three and you know I was on class council for senior class and helped do, um, a lot of the prom planning, flowers, pictures, stuff like that." The demographics of his primary school education were similar to his high school, "all of my schooling experience, except for like uh kindergarten and first grade was in predominantly white schools" and this experience has a lot to do with his choosing UPri for college. "So it was just, you know just uh, like I was given the option just to try something different, learn in a different environment so… I kind of wanted to go to a predominantly black school, so that was like the first thing that opened me up to looking at [UPri]."

Rorke's major at UPri sits at the intersection of two departments, "we're closely knit with electrical engineering because it's the same department and essentially computer engineering is a mesh of electrical engineering and computer science and they've taken the parts from both of those majors and combined them to create this computer

engineering major..." Rorke's interests and goals are focused on engineering hardware, an area that he'd had the chance to explore pretty extensively even before coming to college. He'd done a lot of work taking computers apart, troubleshooting issues for colleagues, and built a lot with his hands, so highlights what he sees as his unique pre-college experience, while also describing how late in his college program, hands-on working projects were introduced.

> for the first two years, you don't get to do as much like hands-on, physical stuff, it's not really much opportunity because like I said, many people are not like myself, and they're not expected to have that type of ingenuity or know-how as far as the inner workings of a computer so, um, I know like in the laboratories, like later on, like third or fourth year, you go into specialization more or less of your field… so I really don't believe that I'll get to do, um, that in a classroom setting until like third or fourth year.

We start to see some of the courses and workload that Rorke has shouldered in his first year at UPri as well as what he's found success in, versus what areas he's struggled in.

> I could tell you that I have mostly like A's and B's in everything last semester and this semester everything dropped down to like B's and C's stuff like that. And as far as like saying that I had more challenging classes last semester, like I had, um, Introduction to Programming which [everybody] will tell you is very difficult and very time consuming and Intro to Engineering... then this semester I didn't have like... major engineering courses except for Intro to Engineering 2, so.

A theme that stands out in Rorke's story is that he does not seem to equate hard work with a high grade point average, as some of the others students in this analysis do. Rorke

instead emphasizes the importance of hands-on work, practice in, and a passion for his field of computer engineering hardware. This is significant because his identity and success, rather than being defined by good grades, is defined by effort, hard work, focus, and an ongoing and continuous practice of his craft.

Rorke identifies himself as a very sociable person, noting multiple instances of networking with students and other colleagues, even going so far as to connect his social identity to his astrological sign. "It's been easy meetin' people!... I'm a Libra so like I'm kinda, like I see both sides of everything... so I'm always open to finding someone else's perspective, so it's really broadened my horizons... been very easy to get perspectives that I never would've thought of before." It seems that socializing gives him the opportunity to see life from a different perspective, but this seems to also apply to his being able to specifically see engineering problems, and his career path from a different perspective as well. Part of Rorke's identity is defined by his interest in computer hardware. "well I'm what you would call like quote unquote I guess a computer nerd, that's what I do, that's-, I love computers, that's what I do." And Rorke pursues this interest in working on computers both inside and outside of school. "And so like I'm, I'm forever customizing mine, adding something here, adding something there, um-- new software, you know, just to stay current because it's everything-, everything's ever changing."

At the same time, he notes that he expected UPri students in engineering to be of a somewhat higher caliber, in terms of hands-on experience, but has not yet found students of that caliber, "maybe it was my expectations when I came to college that, um, I'd be surrounded by a lot of people that were on the same ability level as far as like in that field, um, but what I found is that most people don't know like what I know, as far as like computers inside and out..." He reasons that hardware focused students are missing from

his experience at UPri, so far due to the fact that his program was relatively new at the time, "like I know a lot of upperclassmen know um software and seeing as how computer engineering itself is a new major, there aren't many upperclassmen that do hardware stuff." Rorke explains his disappointment but also explains that he understands that many students need to go through a more introductory or beginner process in the program. "So that's, I was like a little bit disappointed... because classes cater to the majority like you really can't jump head first into that type of stuff without, you know, going from the basics, learning what's the parts, and like Intro to Engineering we went, what's the parts of the computer, like the CPU, the history and all that..." What's most significant is that he uses this assessment of his program to characterize where he's at in terms of his own learning, and it's this level of experience and skill with computer hardware that define a big part of his identity. "When you're at a certain level you really don't want to go backwards, you want to move forward immediately but you know, and so that was a little bit disappointing but I did learn some things that I didn't know, so."

An important part of Rorke's identity is tied into his confidence in his abilities not only as an engineer and a student of engineering, but also as what he describes as a well-rounded person. There's a telling point in his interview, where he's asked about whether or not he finds himself studying with other students. In reference to his own mentality, and who might complement his process by studying with him, he states,

> if you know nothing but work, work, work... then where's your release? An uptight individual's a little bit, in my experience... harder to study with, like somebody who has trouble releasing or, or who doesn't unwind very often. Yeah they may grasp things a little bit better, simple because they're always on that, that grind but my mind doesn't work that way…

Rorke's describing his thought process here, and how practicing things and thinking about concepts outside of the field of engineering, actually makes him better able to practice engineering, and he seems to look for people that step outside of their subject area in their daily practices as well. He then brings this idea back to his want to find others that are on his same level of practice, or others that share his proficiency with engineering. "I mean get it from me, I may understand it from you immediately but it... we're not helping each other. And it's like easier to, to go through something with, when you have somebody with you, like working along with you at the same pace." Rorke goes on to explain, "You have to have it up here, and [if] they're like, "Well this ain't right," and you're like, "Okay, I understand it now." But like you didn't really arrive at it on your own and like, like by working through the problem, somebody just told you, you kind of lose something there." This sequence is interesting, because on the one hand, it seems that Rorke is emphasizing the importance of diversifying one's experience by stepping outside of engineering, and he wants to find others to study with, that also do that. At the same time, Rorke wants to find someone that is as proficient as he is. It seems that only in those cases does he feel that studying and working together is efficient and worthwhile. This brings into frame Treisman et al.'s study of Black and Chinese calculus students at Berkeley. Treisman found that "the Black students typically worked alone. Indeed, 18 of the 20 students never studied with their classmates…" (Treisman, 1992 p. 366). The Black students "didn't have a clue what other students in the class were doing…" and this disconnection with other students played a role in their challenged performance in class (Treisman, 1992 p. 366). It's hard to tell from Rorke's description of his process, which bucket of the qualitative coding I employed, might specifically apply here. Is Rorke the student that is disconnected from his classmates in these courses, and is his disconnection due to his assessment of his classmates' levels of understanding? Would an educational researcher believe that Rorke is doing far too much analysis of his colleagues' level of understanding, and being far too picky about whether or not those

classmates spend enough time outside of engineering? Alternatively, Rorke might be applying this deep level of classmate assessment in a much more efficient way. Maybe this process has allowed Rorke to find what he deems as a perfect cohort of students to work with that are on his level across these many different spectra. Either way, Rorke's level of analysis of others is impressive by any student standard.

Additionally, it seems that Rorke has had an unsatisfactory experience with advisors at UPri that areis similar to what other students in this analysis described. He states, "my advisor... well I used to see him every day, or twice a week last semester because he was one of the teachers of Intro to Engineering." But it seems as though his advisor is struggling with some of the same challenges that faculty and administrators face at UPri, as described by multiple students in this analysis. "This semester, I've seen him zero times I think that's in part because he's piloting this whole computer engineering thing…" Earlier, we saw the students in the analysis describe their advisors and faculty members as overtaxed, trying to balance research, teaching, advising, and also work in their specialty field. Rorke explains that his advisor is also,

> the head of the computer engineering department and uh, I'm not the only one who hasn't seen him nobody has seen him, none of his students have seen him. And um-- he's still an active engineer. So mash like all of the administrative responsibilities, of running a department in a new field, and a new major, with whatever work he's doing on his other uh studies...

In reference to how advising in the Computer Engineering program could be improved, he states "I would like to say like if they had more people available, um, to advise you like more or less, or the duration to go in like when you're choosing classes and stuff like

that." Rorke goes on to explain that when one cannot access their advisor due to some of the aforementioned constraints,

> you end up with somebody who just looks at it like, because they've got student[s] who advise and, and you find them taking you on because you have nowhere else to go, they kind of really don't give it the justice that it deserves... they can't take on twice, twice the amount of work. And so they kind of look at it and they may not catch things that a dedicated advisor would catch...

Rorke experienced some of the same challenges that others in the analysis faced in terms of taking, or not taking classes that were required for his major or were otherwise beneficial in some way for learning in his degree program.

Rorke has been on the path to working with computers since childhood, and it was the specific focus of the UPri Computer Engineering major that drew him to the college. "And um, but I'm real big on computers and my-, like it was already set in stone that I wanted computer engineering to be my major, and not many schools offer that since it's a new majorand so that kind of narrowed the choices down a lot." And his experience with computers goes much further back than the transition from high school to college. "I've always been interested in computers, it's something I kind of just take to, um, it was one of my talents and long time." Rorke's interest and his identity go hand in hand here, as he seems to define himself by his skill and experience. He tried to trace his identity and interest back to where it began,

> I really can't tell you when cause like we got our first computer in-- it had to be like, I was like fifth grade, um yeah, and since then like-, well actually no. We had a computer before that but like modern time type of computer, and we had-,

> my dad had the original like personal computers like giant Radio Shack thing that sat on this big desk, big table we kept in the back. But yeah, I played on that too, so it's, it's always been a part of me so.

As he traces this back he recalls a pivotal moment in childhood, with a family friend that worked for NASA, an experience that seemed to impact his interest path, and ultimately his identity.

> Um, my first computer that we purchased, uh, it broke... and like my father's friend is, um, well he was a computer engineer for uh NASA and... he came over and fixed it, and was like working on it out in the open where, you know, and I kind of took to that. I wouldn't say more or less like he showed me part by part or, but it was more or less like looking and like, "Okay, he's doing that. Alright so, when it happens again, I can do that," or you know, and picked up from that.

The idea that Rorke could see this man's process in problem solving, troubleshooting, and fixing the computer, then note the ways in which he could recreate that process to solve future problems, is very telling, especially due to the fact that Rorke seems to apply that self same process to problem solving in school work when he gets to college. Rorke recognized his ability in the field of hardware early on, and made choices to support his skill. "Classes in high school I took, I took programming in high school like I went after that as, you know, as something. Because once I realized that it was something that I was good at, um, I took classes…" Additionally, Rorke pursued this practice both inside and outside of school at the same time, "in addition I did like work on the side like repairing, building, stuff like that. Um so yeah, as far as classes I took programming and I took networking two years of that in high school." He creatively crafted this skill set over time

to get better and better, while doing independent work that pushed him to the bleeding edge of his understanding of the field. Rorke explains,

> as far as computers like I'll, I can read something and I'll get it like that and be able to do it and produce it. But learning the parts just by taking stuff apart, um, like after we got our second computer, um, the first one was mine and I just tinkered with it and played with it and that's how really I learned...

Rorke goes on to describe his process of learning and practicing in college as well, "we purchased wholesale parts and.. basically we customized um systems to people's… and build a computer from the ground up, and the software and everything…" His interest is so powerful that it pushes him to use his own money to purchase hardware parts and build in his spare time, then apply his learning to help others solve computer problems that they have, "as far as like people having a lot of computer trouble like I do that. Anything that's wrong with your computer, I look at it, fix it, stuff like that." Rorke gives a more specific example of his process at UPri as well, "I've fixed almost everyone's computer in the dorm." The interviewer asks, "Do they just know to come to you..." and he replies "Um, I guess it's kind of just known now, but like at first I was like, you know, "Yeah, I work on computers," [inaudible] I guess it just kind of gets out." The interviewer goes on to ask "Do you make any extra money from that?" and he replies "Yes, definitely (laughs)." From a hardware perspective, Rorke pushes himself to the pinnacle of his practice by actually just building his own computer, "I actually, when I got to [UPri], uh, I came with a laptop. When I got here, I built my own personal computer, my own system." He's extremely interested in computer engineering and hardware, and defines his own identity as such. Additionally, this identity is defined by others around him, as they know him as the guy to ask for help, when they have problems with their computers. Rorke's had these impactful childhood experiences that sent him

down a path of interest, he defines his identity based on this interest, and sees it reinforced by others around him to the extent that he actually gets paid by others for doing what he does, even before he's able to graduate from school, or start on a more formal career path. He also pulls this experience of helping others and getting paid for it, back to the impactful experience he had when his father's friend first showed him how to solve hardware problems. He thinks of his father's friend, and Rorke relates his own practice of helping others to the qualities his father's friend has, which also originally started Rorke on this path.

> I like him and... he's very pleased with his work and it seems like when I look at him in doing his work and I kind of see like a part of myself as like, if he's this happy and like we're kind of on the same level as far as how much he enjoys computers and you know like his face lights up whenever you talk about... "Oh, I have a problem... that's kind of the way I am... like really actually very happy to help someone, um. Many times I'll do it for free... because it's something that I enjoy.

This example that Rorke sees in his father's friend, also gets at Rorke's level of attainment. He sees a practicing computer engineer from NASA that loves to solve problems and loves to help people. It's easy for Rorke to come to the conclusion that these are the qualities that make someone, at the very least, a successful and fulfilled engineer. Rorke can then see that he feels similarly fulfilled by solving problems and helping others, and ultimately the jump we make to Rorke then seeing himself as a good engineer because of these qualities, seems like an easy one.

In addition to Rorke's interest, his race seems to play a big role in the formulation of his identity as well. Coming from secondary schools with large white populations, race also

played a role in his choosing UPri for college. "To see-- so many African Americans [at UPri] achieving at such a high level that was, that was big... even though like my [high] school was predominantly white and everything, but there was a lot of black students there, not many of them achieved the way that they should have or could have..." This notion of the importance of race in Rorke's identity when it comes to school demographics, is not just about representation, it's also about Black students that are successful and functioning at a high level, at a level at which Rorke sees himself also functioning. When Rorke reflects further on his high school experience he explains, "so it was like, basically when you come down to it, it's like you have to choose like, you can hang out with all those bla-, you know with all the African Americans and, for the most part not really achieve your full potential, or you can like buddy up with all the Caucasian and Asian students and you know..." It seems that in high school Rorke had to make a choice about what groups of students he was going to spend his time with, "and I really don't like that stereotypical type of like mindset where it's like if you hang out with these people, like that who are not gonna achieve." It seems that now in college UPri has provided him with new access to students that share his racial background, but also share other parts of his identity like the need to achieve success in his field. Rorke describes UPri further, "it's like more of an environment where black people are set to achieve and, and it's like that's where I see myself falling in, like I try to achieve and I want to achieve so that's, that's what made it feel like home, like it fit me to be here." Race, engineering, and career goals play a role in what seems to be Rorke's ideal identity, and these facets of that identity seem so far, for the most part, to be internally defined. However he shares details of an experience he had while in [Trunk] City possibly related to his racial identity being defined externally by others around him.

> Um it's the outside experiences that have been bad, that've kind of put a negative light on other things that I've encountered here like just being in the [Branch City]

> metropolitan area... there was one instance where uh I was going to like the [Trunk] City, and um I had an incident with a police officer and he said that I didn't pay for the Metro and it seems like really minuscule and really small but it's a heavy offense down here and it was like, because of that incident I was like in and out of court a bunch of times, appealing...

Rorke is very clear in this description that the officer "said" that Rorke did not pay for his ticket. While we don't have all the details and background to prove that Rorke was being discriminated against because of the color of his skin, I would argue that there is a very high probability that this is what happened. Rorke, by his own description, seems like a very dedicated student and a generous classmate that had had no legal problems up until this point. Whether this was a case of racial discrimination or not, it had a great effect on Rorke's emotional well being and his performance in school, he explains "because of like the time that I spent going back and forth to that and worrying about that, because I've never been in trouble with any law, and it's the fact that it was not like a, a minor offense, they take it very seriously here, it was a criminal offense, tried in a criminal court um it affected my work and my ability to work..." It's interesting to think of the experience of a Black man inside his university surrounded by a majority Black population, how that population identifies him and how he identifies himself. We can then think of this man stepping not far outside of this inculcated environment, although in the same metropolitan area, and imagine how the demographics of that area affect both his own and others' perspectives of his identity.

To surface data on Rorke's notion of attainment, we'll look into some of the work that he does to help his dorm mates troubleshoot their computers. The interviewer asks, "let's say I brought my desktop to you... How do you go about finding the problem?" Rorke replies, "Well, um first we pinpoint, or you describe to me the symptoms that seem to be

troubling you. Like what's different, what is it doing that is different." In the interview Rorke states that problem solving is an inherent skill or quality that an engineer holds. "I think I possess problem solving, um math skills, science. I love computers. Um, those are my four really." We explore each of these but problem solving emerges in the instance of troubleshooting his dorm mates' computer woes. Here we see that he has a well laid out strategy for solving problems. "And then just either from having seen the problem before or um--process of trial and error, knowing how different things or different parts of a PC's, uh how they interact and what they're in charge of, you pinpoint the problem." Rorke believes that an engineer has to be a good problem solver, he also sees himself as a proficient problem solver, therefore his level of attainment of the career goal of being an engineer is high, as he has the qualities of a good engineer and can therefore become one.

Exploring some of Rorke's practices and beliefs about engineering as a field, we find him sharing that he "was part [of a UPri-student organization] and part, uh, NSBE... I do have involvement in both... yeah I'm the vice president of uh freshman engineering." So Rorke is engaged in campus activities and ties his intentions here to both learning from others and networking, to make connections that might help him attain a future career in the business of engineering. Communication talents, although not overtly described by most students in the analysis as a characteristic of a good engineer, is constantly brought up as a means to another end that is tied to attaining a career in engineering. In this case, Rorke wants to stay in contact with people to find future opportunities. He explains the importance of events he attends, related to these student organizations,

> Because they like-, these are people that are like in prominent positions, like city planners and you know actual, uh, corporate heads, heads of engineering firms, so these people had the know how, obviously been successful in what they're doing, so down the line if you ever need even something like an internship or something

like that, these are the people you want to keep in contact with and leave a lasting impression on so.

When the interviewer asks, what would make a person a good computer engineer, he replies,

> first and foremost, love for your craft or your skill. Like if you don't love it, and love to do it every day you're not gonna be good at it... if you don't love it, it's like-- you're capping your potential. Whereas when you have that love and that passion for something, you optimize... you want to have a strong background in mathematics and um science.

As Rorke makes distinctions about one's experience with math and science specifically, we see that he also thinks highly of his own skills in mathematics and science and he refers to engineers being "book smart" in this way. "I don't think that that means that anybody else is not intelligent, I just think that maybe engineering majors are a little bit more gifted as far as book smarts goes. Or grasping of mathematics and um science." In reference to engineering students he states, "it's just like, they're just, the way to put it is like book smart, it's more book smart, I think that'd be the best way to put it without offending anyone." Rorke believes that good engineers are well versed in math and science, he sees himself as being well versed in these fields, and therefore he sees himself as having the potential to be a good engineer. To a certain extent, he actually sees himself as an engineer already, as he's created multiple opportunities to practice what he believes a computer engineer does on a daily basis.

This is a level of engagement that Rorke has described himself as having, in numerous examples in the analysis, so far. He has the love and passion for what he is doing, and

this equates with being a good engineer for him. He goes on to explain, "And you should have, um, like, be a problem solver, a good, a good problem solver will always be good in computers. Because what do most people need someone to do to their computer? Fix it." Rorke gives us examples when working on his and his dorm mates' computers of how he breaks down a problem, through trial and error, identifying what the cause is, and then working to rectify that. He also emphasizes the importance of moving quickly to solve that problem. "So finding a problem, um, quickly and um, solving that problem effectively... and uh-- time management I guess, has a lot to do with it, because nobody wants someone to linger on something..." Rorke definitely believes that he has the skills to be a good problem solver, and therefore can see himself as an engineer.

Actively exploring his craft and embracing his own learning outside of the structure of the educational institution, seems to be an important part of Rorke's path as well.

> I actively sought out like people... so I can fix their computers... uh I started like doing computer tutoring... to use software and become adapted to it like any type of software like photo editing, software editing, music recording and I do all of those things... build websites... so I'm always doing something that is involved in the computer... so that's how I guess I stay sharp on my skills and my abilities.

Although Rorke does not directly state that this mentality is also what makes a good engineer, it seems to fit into Rorke's pursuit of expertise in engineering. He is constantly finding ways to practice his craft, which also ties back to his emphasizing the fact that an engineer needs to have passion and interest in their craft, to be successful at it. This concept of being authentically engaged with the practice of engineering seems important to Rorke, but he also refers to the idea of being dedicated to, and focused on his work. He weighs being inherently prepared with the skills necessary to work in the field of

engineering, with this idea of an engineering student having to focus very intensely on what they have to do to succeed. He starts by saying, "Uh my abilities, like um-- I'm strong in math um writing skills, my writing skill's very strong. I'm like a well-rounded person." He notes the math skills he sees as necessary to being successful, but he again stresses the importance of being well rounded, i.e. having interests and practices outside of engineering, as well as having skills in the humanities. Rorke then draws his understanding of the skills he has inherently like math, into this idea of focus, and having to apply that focus to be successful,

> I mean I was always focused but didn't have to work very hard because, I don't know, that stuff just came very easy. When I came to [UPri], not that the work was so much harder, it was just that I wasn't prepared for the fact that uh-- I might have to focus a little bit more... like a little bit of a shock if you're used to breezing by.

So some skills like math are a given for Rorke, he has to be sure to focus on what he's doing to find success, but there is a piece of this focus that is also appealing to him, "I do the challenge but, you know, the challenge is what I like..." The interviewer asks, "What is it about the challenge that you like?" and he replies, "it incorporate[s] a lot of like problem solving skills and um, it's like raising to the, to the occasion. That sounds kind of corny but, you know." It seems that inherent in this process of studying to be an engineer, is also being challenged and this is something that he enjoys.

Rorke continues to create this challenge for himself by delving into areas of study and work that complement his pursuit of computer engineering. For example he's signed up to take Japanese and explains why,

> a lot of people will criticize me for taking Japanese as an engineer, but my whole rationale or thinking behind that is that... when I get out of school, I really don't want to work as an engineer in a laboratory... I see myself um doing something where I develop something or... work with a team that develops something... and then marketing directly to someone or a company that has the power to do something with that technology... like have the ability to like to someday go to Japan and um actually conduct business. You know, cut out the middleman.

Rorke has clear sight of at least a general end goal after his education, and that is to go into working at the intersection of business and engineering. In this instance he sees that learning a foreign language will serve those goals, so he takes on that challenge. In addition to generating work for himself by soliciting odd jobs that help his colleagues solve their daily technology problems, he plans to do work in the summer as an electrician because it is a related labor field.

> This summer, I'm working as an electrician and though it's not right on top of my field um the thing about computers is you can do anything else and still connect with computers... like working with electricity is partly connected to computer engineering because we do computer work like connecting, uh, setting up offices and stuff like that... So that's where I make the connection with my major.

Everything that Rorke does seems to be tied to reaching this end goal of practicing computer engineering, and although at an early stage in his educational career, he still has his sights set on specific fields and careers within engineering. He states, "I see the finish… I have a very clear good idea of where I see myself like when I graduate and what I want to do so that is where I want to go with it so, whatever it takes to get there, I'll go over the bridge, under the bridge, around, whatever but you know, so I'm gonna

stick it out." Rorke has drive and focus, and believes that he will do anything it takes to find success in his field.

In regard to his own learning in UPri classes, "I think real world application's very important yeah, it kind of takes something away like if you're learning something, you can't see like where it's gonna ever be applied ever again in life then, [inaudible] learn it, and it's, it's harder to stick." This notion ties into his exploration of fields and experiences that complement computer engineering, and more importantly characterizes his understanding of the utility of a career in computer engineering. One the one hand, Rorke wants to engage in study and practice that is practical, in that it gives him the ability to see how to apply the concepts he is learning. To that end, he practices computer engineering in every way he can. By generating work for himself while also formally studying engineering, he is in a way, proving the utility of an engineering degree to himself by doing jobs in the field. As he imagines his end goal of working as an engineer, he see himself being challenged by solving problems, something he's expressed great affinity for, and being able to share and help people as his father's engineer friend has been able to do happily, and in a manner that seems to has made his father's friend feel fulfilled. This idea of utility seems to reflect back and forth between Rorke's current practices as both an entrepreneur and a student. He states, "there's like an end of the road where I want to get so that is my real world application. Everything that's in between applies to what I want to get to so. If you-, if you're trying to find meaning in anything that you're doing, [inaudible] that's the way I would do it, because it applies to what I want ultimately, to be my goal so."

When we think about Rorke's understanding of the cost associated with both studying engineering and practicing engineering, it's of interest that he has some knowledge of the dropout rate for engineering at UPri, stating "And so the engineering dropout rate is like

45% 50% something like that. I've seen it this year so." He combines this statistic with his own anecdotal evidence as well, "I keep a close-knit group of like five people out of my close friends, yeah all of em have already withdrawn from engineering, um, as far as like in the Intro to Engineering class, I seen it drop almost half." Rorke understands the pressure and demand of his major program, and although he has passion for the field that he both studies and practices daily, he can see what parts of his daily life are difficult due to engineering, when he compares them to the large number of activities that he took on in high school.

He begins by referencing his current course load at UPri noting that "I would take a few less courses... It's a lot I took 19 credits." He then states, "I was used to the juggling act in high school like eh, I did all my class work, I had a job, I ran track and I was in all these clubs, didn't seem to be a problem... like theoretically within the schedule, I had time for it, let's do it." Above he'd referenced the idea that in hindsight, he would however have taken fewer classes at UPri, "And then when I get [to UPri], cause it was a little bit more involved... So I would take less courses." This cost, and this dropout rate that he sees around him, is actually a surprise, "Um the fact that a lot of people dropped off, I didn't, I thought they were just kidding... They're like, well, you'll find that a lot of people in engineering won't stick around. I was like, "Nyeah, looks like everybody will still be here..." so yeah. That was a surprise." The fact that this was a surprise to Rorke even as those around him saw it as commonplace, also speaks to Rorke's identity and his interest in the field. Here and in other instances, Rorke shows that he is engaged in what he is studying, and in essence, in it for the long haul, and therefore surprised when he sees that others might not be.

As the interviewer goes more deeply into Rorke's daily schedule, we see added costs and requirements he undergoes as he studies at UPri. "Um, I was kind of wrapped up in like

just going out to see D.C a lot... I worked a whole lot, like job, job... Silver Springs, at Dominoes, the manager... Um, not full time, like 30 hours." The interviewer states, "30 hours. And then you had your engineering and your tutoring. How did you manage all your time?" He whispers back, "I don't know." He goes on to explain "it was like-- a necessary evil, like I had to work... Uh, to pay for school. So that's something that I would, definitely am trying to change, um. My situation as far as like having to work for school is like, it's like my inability to get a loan." The interviewer asks, "Do you think the pressure of having to pay for your own schooling affects your grades a lot?" And Rorke replies, "Very heavily, because I felt it so much more second semester. This is what I said like, my second semester was-- horrible." So we see that in addition to all the work that Rorke has described, he's added on 30 hours more work a week, that has very little to do with his studies in engineering and therefore most likely requires more overlap in resources, energy, and time. And when Rorke describes his typical day we see again, as we've seen with most of the students in this analysis, that sleep is deeply impacted by the study and work requirements of their programs at UPri. "Typical day, okay. Class from like 8, wake up at 8, go to math. And um, well that's if I-, if I've slept if, if I've slept.... Um, there's a couple reasons why I wouldn't sleep. Um, sometimes I have work, I-, like doing schoolwork and I wouldn't sleep." And we see how little sleep is actually possible to achieve when we hear more about his work schedule at Domino's Pizza. "Most of the time like 5:30, 6 until 12. That's what time I got off, that's what time-, because I locked up so it's the time it closed. And then so I'd get home maybe 1, 1:30." We can clearly see that a day full of classes, then a night full of working, leaves very little time for studying. "Then I would do more work or try to sleep... but like, if it was one of those days where like you're really, really tired, and you have work to do and you can't cause you're so tired, you fall asleep, and that's where like you really see the effect..."

Additionally when it comes to cost, although Rorke describes himself as proficient in the the skills of being an engineering student, he does not see the requirements of studying engineering at UPri as some small feat, instead he describes it as very difficult, and this detail shows us what a costly endeavour these studies can be.

> Engineering [inaudible] like arts and sciences and stuff like that, um, it takes more dedication to work because it's harder... I don't mean, not to put down anybody else's major, but I think engineering's the most difficult and the most challenging majors, on the whole campus... as far as, um, knowledge like having the intelligence and the knowledge... but besides that they're honing on your skills of like presentation, and um, creating an individual that like, marketable.

Rorke points out the difference between what other majors have to shoulder, and what an engineering major has to shoulder to be successful, and he sees engineering being the most difficult degree to purse at UPri. He describes the teaching and socialization of this process, as the school forging the student into a skilled individual, that is then able to enter the job market successfully. He goes on to compare this to the business school that similarly creates students that are marketable, except in that case, there is no need to take on the challenging concepts and knowledge required of an engineer, further distinguishing the cost and sacrifices that are required of his field. "So like I see what the business school does that creates individuals that are very marketable and very skilled, but at the same time, engineering provides that and, um, the know-how. Whereas it's more mentally and demanding than I feel any other curriculum." Rorke also points out the overall time commitment of the program itself. "Seeing as how when you come into engineering, you're looking at five years. And they've shortened it now, so it says four years on paper but how many people are actually graduating in four years?" The interviewer asks, "So you don't see yourself graduating in four years?" and Rorke replies,

"Um, not unless I spend a bunch of summers." From Rorke's perspective, the engineering program is basically five years of the most challenging content, forced into four years of study, and the only way for him to alleviate some of the pressure of some of this cost, would be to sacrifice his summer breaks as well, which ultimately would be an additional cost itself.

Rorke goes on to describe his interpretation of the reasons that many students do not finish the program, speaking more specifically about particular classes and professors that he believe could be the cause of dropouts.

> Like, most common, "Oh, I didn't want to work that hard, I didn't come here to work that hard," or uh a lot of times one class makes or breaks people like I find that the uh programming class that I took, um, teacher was very difficult, she was very just, I don't know, I didn't like her personality, a whole combination of things. And she was a make-or-breaker because like-- you have to go through her to get on it's not a class that you can skip, it's a major class. And that decided for a lot of people right there. Uh, people who failed or were doing poorly like, "I don't want to go through her again. That's it." Uh.

This is a significant point, as a number of other students in the analysis also note courses whose outcome can decide whether or not a student continues on to graduate in the field and become an engineer. Rorke notes a class that was very difficult for him as well, that is a prerequisite for many engineering programs, "Um physics was difficult... it was almost impossible... it's just hard it's just really hard. Uh, a lot of people will tell you that physics was hard, um I don't know why physics was so hard but it just was and I've taken physics before, and I got a good grade in it. I don't know this was just really hard." Rorke's noted proficiency in math, past success in physics, and his dedication to his

work, also support the hypothesis that there was something unnecessarily challenging about either the design or the execution of this class at UPri. Rorke's earlier reference to the programming class above, and one particular professor being a "make-or-breaker" is additionally unsettling, as experiences like this should not be the norm in engineering programs; one's future should not be decided by challenges posed by pedagogy. In addition to the many costs that we see engineering students pay to pursue their goals, a multitude of poor experiences with poorly designed or unjustifiably challenging classes, should not add to these costs.

As Rorke shares some of his insights about his own passion and interest for engineering, as well as what drives him, he uses examples of his interpretation of the passions and goals of another group he sees in his department. "And it, it comes out of passion, what people's passions are. Um, everybody's driven by something, so um I know some Caribbean students, science and stuff's not necessarily their passion, but they're driven by the fact that um it affords the type of life that they hope to have for themselves and their families, so they're driven to go to that type of profession..." Exploring his interpretation of what drives the Caribbean students he sees in his classes, he creates a hypothesis, which concerns the utility he believes that Carribean students ascribe to a degree in engineering. He talks about what seem to be passions that he and this group share, but he also sees that much of their drive comes from the need to make money and support their families. Although he does not say it directly, one can surmise that Rorke also views getting a computer engineering degree as holding this utility, the idea that it will afford him a lucrative livelihood. Rorke uses this idea of what drives a student, to reference some of the attrition from the program that he'd previously talked about, students that did not have the wherewithal, for whatever reason, to finish their degree programs.

> the drive has a lot to do with it, whether it be fueled by your passion, for whatever it is, or other outside reasons that you need to go into this field, you're dedicated in your drive enough to do that, and a lot of people come to engineering and they're not prepared for all that kind of work-, or don't really want to be pushed as much as it does push you, and they'd rather breeze by, or find that some of those things are not their strengths, a lot of people come to college find...

Interestingly, although not a Caribbean student himself, instead identifying as Black and american, Rorke spends some time in the interview describing students at UPri from the Caribbean, and how well represented they are in the engineering department. The interviewer asks, "Okay, are you Caribbean American, or just American?" and he replies, "Nope, just American."He lays out his interpretation of the different characteristics that affect Caribbean students' and American students' paths in engineering.

> Well, for one thing, it is kind of stereotypical, but it is a, a fact, um, most people in engineering are Caribbean and they're older. And that's-, those two go hand in hand, the Caribbean students um unlike American students, um, go to work first and it kind of you know-, there's a majority of them in engineering as if, other than like arts and science and stuff like that, we have a lot of people coming in undecided, not knowing what they want to do… And I don't know if it's because I mean they're more older, and they're just past that stage of their life where they're just a little bit more mature but they just, they're just more dedicated to the work.

Rorke, adds a data point to some of the hypotheses that Myesha shared around students from this demographic being older and more experienced than american students. "Um--I'm trying to think of another American student in engineering." The interviewer asks,

"You can't think of another American student in engineering?" And he replies "There's so many Caribbean students..." When asked to compare the two groups level of drive, he states, "American do have the drive that-, the ones that are engineering, if they're engineering, they have the drive. It's just different cultural…" Additionally he believes that students from the Caribbean that come into UPri at an older age, have a different level of motivation and focus, as they have already had experience in the field of engineering, and the degree they are pursuing is a degree that will supplement their already established careers.

Cost also seems to play a big role in Rorke's comparison of younger american, and older Caribbean students. "I mean I think, I think it's because, because of, um, what you find a lot of times is that they've sacrificed, not only them, they have sacrificed, but their family members and other people. Not to say American students don't sacrifice a lot of them don't, but many do." Rorke sees that all students, whether from the U.S. or from the Caribbean, have some level of sacrifice they must make to pursue engineering, it just seems to be a different type or a different degree of sacrifice.

> Um but the Caribbean students, they sacrifice a lot to come to college, especially as far as, as far away as [UPri] is from the Caribbean and how much it costs to go back and forth um and they do give up a lot more, and a lot of them leave jobs that they've already secured for many years um to come and go to school.

Rorke compares this to what he sees as the American experience, "Whereas an American, you don't have that. They come right out of high school and they're still like, high school was like fun and games." He even uses his own high school experience as an example, "I personally didn't work very hard in high school, wasn't hard... I can see where it's like, "Well, college may be the same," it's just, you're not used to having to focus as hard."

This is significant when we also consider some of the challenges Rorke noted that lead to a pretty high dropout rate for students in engineering. He begins by referring to engineering students in general, "there definitely is… a difference between other students and engineering students. Other than that that most of them are Caribbean but um just uh, well ability level. Because a lot of people coming to engineering and they find out it is not for them because it's too hard." When we consider the international students that are entering UPri, having already worked in the industry, we can see that these students might have the added benefit of knowing they already have the ability to work as engineers, because they have already practiced. So this question of whether engineering is for them or "not for them", might already have been answered, and this might be why they've come to UPri in the first place. "Yeah, they are different. Um-- like a lot of American students come to college and like want to party and I don't know whether it be that Caribbean students have already surpassed that seeing as how so many of them are older, I mean they have their parties too but um it's not as frequent." Rorke is noting qualities like age and the period of life that these students are going through, and then comparing that to the students that he seems to relate more to, Black american students that are recent graduates from high school. The alternative experience here, being a younger american student and not knowing what ones wants to study, and having one's first introduction to engineering be a difficult programming class or an unintelligible introductory physics class, can have very deleterious outcomes for a student. If hypothetically a student is actively exploring her interests, she'll have gotten through one of these classes or dropped it, thinking that the content and the struggle in the course are representative of what engineering, and being an engineer are actually about.

Interest

Rorke is extremely interested in computer hardware, and has been since childhood. He became interested in computers early on, having had the above experience where his family friend showed him how to fix the family personal computer, and this seemed to make Rorke's interest grow. One gets a sense that when Rorke saw that it was possible to open up a computer, work on its parts, modify it and fix it, he recognized that there were new categories of tinkering and building that he could apply almost immediately. He seems to have sought out these opportunities to take hardware apart, build it from scratch, diagnose and solve others' technical problems, almost as a sport. It's clear that this work is hobby work for him, as in, it's what he loves to do in his downtime, but it also seems like this practice is more systematic than just a hobby. Rorke has found a way to systematically build out his skillset, get better and better at what he does, and widen his scope of practice. He, more than any other student in this analysis, seems to be interested in the art, craft, and practice of engineering.

Identity

Rorke is focused on specializing in hardware, takes computers apart, builds them from scratch, and is the go-to-guy for troubleshooting computer problems at his dorm and other social circles. I continue to note the very influential experience when a family friend that was an engineer for NASA fixed the hardware of a personal computer for his family, as it seems to play the strongest role in the formation of Rorke's value of identity. Rorke identifies himself as a very hands-on person. He also identifies himself as a computer nerd, jumping at working on others' computers and upgrading and customizing his own computer constantly. He loves computers, that is what he does, but also who he is. And actually Rorke expected other UPri students to have a higher caliber experience

level like his own, but so far he's not found others like himself that have worked on as much hardware as he has. Rorke clearly identifies himself as an expert multiple times. As an expert he therefore is also very selective about the students that he chooses to study with. On the one hand, he wants them to not be (as he describes them) wound too tightly. In other words, he'd like the people he chooses to study with to have interests outside of engineering, while also holding the same level of expert knowledge that he holds. He gets at wanting to avoid one student being behind the other in their progress and thinking, so that they can instead solve problems together, on the same level of understanding. This is an extremely interesting part of the way Rorke identifies himself, as this line of conversation in the interview actually pushed him down a track on which he had to reflect on how he assesses his own performance, and then compare that to whom he would most like to talk to as he worked on engineering problems.

Additionally, Rorke wanted to go to UPri to see other African Americans around him functioning at a high level as well. In high school, he notes that there was a racial division, in that the people that were academically dedicated there, were also not Black. Essentially Rorke wanted to see other Black people around him that were functioning at his same level of success. That level of success also seems to be a level that is gauged by knowledge and practice, rather than by grades and performance in classes alone. Rorke notes that he is on a path that he is passionate about, and sometimes it takes passion to create the drive necessary to get through a program like engineering. So part of Rorke's identity is defined by a passion strong enough to overcome a very challenging course of study.

Then we find that Rorke also cannot recall one other Black american student he knows in the engineering department, regardless of skill level or expertise, he cannot think of even one. All the students he can think of are from the Caribbean, and he reasons that those

students have a different level of drive than most of the younger Black american students he knows outside of engineering. These Caribbean international students are also invested in a different way, some already having started their engineering careers and already dedicated themselves to this path before starting at UPri. Through these descriptions, Rorke sets up his interpretation of the identities of two other groups of students and basically lays out the way in which he falls between the two of them, in a way broadcasting that he sees himself as very unique. While he is a Black american student following a more traditional path directly from high school to college, he is also dedicated to and engaged with a career in engineering already, in terms of the work that he does to hone his skill while also making money on the side, helping others with personal computer troubleshooting. As he explains there are very few other Black american students in his program, he displays to us that he sees himself as something of an outlier. He further distinguishes himself from this group that he believes is frequently experiencing a different phase of life, in which they are exploring what they only might be interested in thus, and the ways to go about acquiring the knowledge that will give them access to jobs related to those interests. Rorke identifies himself as someone who already knows.

Attainment

Rorke most immediately feels that engineers are talented in math and science, and sees himself as similarly talented, and therefore perceives himself as having the potential to be a good engineer. Additionally, from his own words, we can see that Rorke has not focused on performing well in classes just to achieve a high grade point average, but instead has showcased his qualities of hard work, focus, and ongoing practice of his craft to get better and better at it. He actually plans to expand this practice by taking a job, at which he'll be doing the work of an electrician and other complementary fields to get

better at his own field of computer engineering hardware. Rorke sees himself as an expert that already practices work in hardware, and getting paid for odd jobs and troubleshooting for his colleagues and classmates. I return to these details because they highlight the fact that Rorke sees himself as proficient, and having the qualities of an engineer as he is already practicing as an engineer. He also sees himself as a strong problem solver and lays out the specific steps he regularly follows to diagnose and treat computer problems, connecting us back to the same experience in childhood where his family friend happily showed Rorke how to carry out those steps. Additionally, Rorke's family friend was happy to help and contribute in this instance and other similar instances as Rorke grew up. Rorke points out that he could relate to this happy feeling, when one contributes and helps another with an engineering problem. So it seems that Rorke's most likely first and best example of what it means to be an engineer, came in the form of his family friend from NASA. Rorke now seems to embody the same qualities that this family friend held, and seems to be experiencing the same feelings and emotions as he carries out the same task of helping another. This idea of identifying the qualities and skills of an engineer, recognizing that one has those same qualities, and then being able to envision or see oneself as an engineer, happens in this instance for Rorke, and his attainment value is high.

Cost

Rorke points out that by his estimates of the data, 40-50% of an incoming class slated for engineering degrees, actually end up leaving the engineering track. He applies this statistic to his anecdotal experience, noting that the five students that he's friends with in the department have abandoned the engineering degree so far, due he believes to it being such a challenging path. Rorke references the high number of units required each quarter to graduate, and realizes that it will most likely actually take him five years to complete.

He notes that the only way to graduate in four years is to then sacrifice one's summer semesters to taking classes, reasoning that that practice is just as good as packing five years of content into four years of study, if one takes that route. Rorke explains that he was actually very surprised to see so many students drop off of the path from his cohort. Prior to his realization, he'd heard from many students that this drop out rate was the case, but did not believe it when he heard it. Rorke was taken aback when he actually saw it happening around him.

We can hypothesize that a good number of these students that are leaving the path are leaving it because it is difficult. Some of the ways we've seen this path to be difficult are heavy and challenging course loads, sleep deprivation due to these requirements, isolation from others inside and outside the department, and extended graduation tracks, just to name a handful of the challenges we've seen in this analysis so far. These are all examples of possible costs that students have to pay to finish their programs, and Rorke seems well aware of these costs, but remains dedicated to completing the program. Even with this dedication, we can assume that he is paying these costs each day he advances toward his degree. In addition to these costs Rorke also works 30 hours per week as a Domino's Pizza manager, then serves on the executive boards of student organizations, sleeping very little each night, which sometimes causes his class work to suffer. Rorke needs to continue to work his job because he needs the income to pay for tuition and cost of living, as he's not been able to secure a loan. This represents the daily, more tangible cost of his time, money, and well being as his schedule seems maxed out.

Rorke also sees some degree of cost in having to be as dedicated as one has to be to the endeavor of studying engineering to complete the engineering degree. He compares this to other majors, and believes that engineering is the hardest of degrees to complete. So we're left with assessing the cost of five years of the most challenging content. In

addition to this, Rorke notes that there are particular teachers that are deemed the make-or-breakers or gatekeepers that design classes in such a difficult way, that they become the lynchpin to a student completing their degree. Some students just cannot get past these courses to complete their degrees. As a case in point, Rorke notes the difficulty he faced taking physics at UPri, one of his hardest classes to date, while it was not at all hard for him at the high school level, implying the possibility that the course was poorly designed and or poorly executed at UPri. It's difficult to quantify the cost of these experiences, but each one of them are recognized by Rorke as part of the pathway, and the experience that is completing a degree in engineering, and overall the costs are high.

Utility

It's clear that Rorke sees that the pursuit of a degree in engineering has the potential to help him make money and be able to begin his own engineering company, or work with other companies to release a product. More than anything the utility of a degree in engineering is defined by the opportunity that it affords Rorke to continue to pursue his passions in hardware. The pursuit of an engineering degree for Rorke is about the opportunity he will have to both make money, and to support himself while also doing what he loves.

Student Case Analysis Summation & Discussion

What follows is a synthesis of what appeared in the analyses, that is of interest in regard to identity, interest, attainment, cost, and value for each case. I've given a summation of the most prescient points affecting identity and motivation for each of the students in the

chart below. Further overarching insights and themes will be covered following the chart. They include career track connections to motivation and identity, the experience of race and gender in the department, experience with faculty and courses, opposition of identity and motivation values, student learning, the international versus the domestic student experience, and the cost of poor facilities and tools. The insights from these cases also contribute to creating a more detailed characterization of some of the "differences in the local cultures at each of the four [APS] schools… associated with complex and different relationships between being at the particular university and being in engineering" (Stevens et al., 2008, p. 361). I'll then close with a return to the original intent of the exploration and the specific questions that this exploration asked, as well as a final concluding discussion of the insights the analysis generated.

Table 3: Case Summation

	Interest	Identity	Attainment	Cost	Utility
Monica	-States that she has been interested in technology and computers since she was a child, but actually seems to not be interested in the pure practice of engineering that she equates with programming and coding as it requires one to have a great attention to detail.	-Black female computer engineer from Park, Illinois that both describes herself and hears others describe her as so sociable, and outgoing that she must not be an engineering student. -Others question whether a person as sociable as Monica could do well in engineering and Monica notes that she has extremely good grades and runs a number of student organizations at the same time. -When it comes to her social nature she seems to want to distinguish herself from being an engineer, which	-Very proficient in math, as well as coding to the extent that she was nearly certified in Cisco as a high school student. -Does not however, seem to connect her communication, management and leadership skills with engineering. -Yet Monica relies on the opportunity to communicate and lead on student group executive boards as the main thing that keeps her going in the field of engineering.	-Sees late nights to fulfill course requirements as a cost, and sees taking classes from professors that equate difficulty with learning as a cost, as she feels the classes she's learned the most from have actually been very accessible, well presented and not difficult.	-As she transitioned between lower division classes and electives found that she was really not interested in engineering. -However she is an academic performer, wanting to do well in any classes she takes no matter the subject and feels that if she continues to perform at the level she's performing, will most likely find success in whatever area of work she goes into.

		she would define as a non-social person as much as is possible.			
Sanaa	-Does not seem to have a great deal of interest in the fields of math or engineering themselves, actually pushing back on her friend's assessment of her as really enjoying math. -Family seems to be very important to her as she is encouraged when she sees a Microsoft employee that's similarly invested to the degree that the employee takes her mother on vacation.	-Sanaa is a Trinidadian female student studying computer science that feels as an international student limited in her employment options and her ability to express her political beliefs in the U.S. -Opposes her identity to the identity that is projected on her by a friend that Sanaa is really into math and engineering, as well as very smart, as Sanaa does not see herself this way.	-Does not see herself as a problem solver, noting that every time she is faced with a problem she has to give herself a pep talk to convince herself that she'll be able to find an answer. -Takes precalculus in college and feels that she has to put a great deal of effort into classes like math to be able to do well. -Sanaa seems to have low attainment for these reasons.	-The degree requires a great amount of work, which goes hand in hand with sleep deprivation to the point that she feels drunk in class during a test and friends ask her if she alright. -Sees studying math and engineering, as well as taking a larger course load from semester to semester as something that she has to endure to attain her degree rather than something she enjoys doing.	-While Sanaa's interviews do not reference the utility of pursuing the engineering degree or engineering as a career track, she does interface with utility in a less traditional way by saying that math as a practice is something that is useful only to the degree that it will help her graduate and get through her courses
Angel	-Strongly interested in Computer Science and hackers. -Strongly interested in math to the point that once he'd finished a great deal of coursework in high school, rather than taking programming classes, took even further math classes so that he could go more deeply into the field and make himself even more adept and competitive in that field.	-Trinidadian man majoring in Systems Computer Science that completed so many advanced credits in high school that he placed out of a number of requirements at UPri. -Pushes himself to maintain a 4.0 GPA and notes that his cohort is one of the highest performing in years, so a very competitive student. -Feels that international students have fewer opportunities for jobs in the U.S. and international students are more regulated by immigration.	-As a scholarship student notes that he has a more definitive goal for success than other students. -Also identifies with being a Trinidadian student, as being an international student ties into this drive. -Feels that his secondary school education back home gave him a superior level of preparation. -All these taken together equate with Angel seeing himself as a successful candidate for engineering.	-The cost for Angel is the huge amount of work that needs to be done to be an engineering student and the sleep deprivation that goes along with that as well as the limited time to do things for himself especially when it comes to having a social life outside of engineering.	-He believes that studying systems and computer science will prove to offer him a lucrative career and offer him a great degree of creativity in his work. -He avoided a career in physics as he believes that there will be no jobs in that research area in the future back home, whereas computer science will afford a bevy of jobs in the U.S. as well as in Trinidad.
Roxanne	-Was initially drawn to electrical	-Black woman from Detroit studying electrical	-Believes that a good engineer is defined by what they	-Time lost is a theme for	-Sees engineering as a means to an end, in that she

	engineering due to her interest in technology and gadgets. - Took off a year to work at a co-op to practice engineering and get as much experience as possible. -Likely though plans to try to purchase her own non-engineering business in the future.	engineering that wants to get outside of her department as much as possible. Feels ill prepared by her high school preparation in math and sciences and outmatched by international students that have had a great deal more preparation. -Sees that she is one of very few Black students at her co-op and sees that she is one of very few women in engineering at UPri.	can practically do and therefore wants to practice engineering as much as possible in internships and co-ops as she believes her program would not have prepared to her to work in the field otherwise. -Opposes this to her professors' views that a good engineer is made by understanding the minutiae of theory and explains that this is why they push book learning but she is more interested in the practice of engineering.	Roxanne. -She feels behind other students due to her poor preparation and wishes she had gottens started earlier, shouldering this view that she is playing catch up with others. -Additionally she sees the work of an engineering student as limiting her ability to build deep and substantial relationships with others, as she is always unavailable to socialize with her friends and grow those friendships due to the incessant engineering work that she has.	really wants to own a jazz restaurant that she does not have to put any effort into managing so that she can create income and relax. -She believes that she'll be able to rise up the corporate ladder of engineering to be able to afford this business.
Myesha	-Struggles with whether or not she should pursue her track in Computer Engineering as she has been challenged by it, but also is not entirely fulfilled by the alternative (language studies) which she knows well but does not feel that same level of challenge from.	-Black woman from South Carolina that feels she was greatly underprepared in the areas of math and science during high school and sees international students around her with better preparation and more success to the extent that she feels stupid. -But at the same time sees herself as outspoken in other areas of discussion.	-Sees herself as a bad test taker and so bad at problem solving that she struggles to even identify what the problem she's slated to answer is. - Internalizes the problem to herself rather than teachers and school once at UPri. -A communicator that always speaks her mind. -Challenged by her own indecision to continue or not.	-The stress that Myesha seems to be carrying on her shoulders about whether she is suited for this field, as well as the displacement of poor preparation onto herself, and her own identity are costs. -She sees herself as stupid and questions whether or not she should continue at all.	-Sees engineering as the practical path in that it will make a lot of money for her, rather than the path that she seems to have a lot of interest in, in language studies. -Additionally sees engineering as a means to an end, envisioning that engineering coupled with language might land her a job or a business in international relations.
Rorke	-Strong interest in computer engineering tied to NASA engineer teaching him how to take apart a computer as a kid.	-Black man highly proficient at his craft, practicing hardware engineering to help classmates and make money. -Surprised there	-Strong in math, science, and problems solving. -Relates to the happiness he finds in helping people with hardware problems to his NASA family	-What engineering students do is so challenging that there is a 50% dropout rate -He gets very little sleep and	-Already sees that work in hardware can generate money and jobs for him and has been practicing for a while -Also a

		aren't others at his level of expertise at UPri.	friend also has since Rorke was a kid.	works a 30 hour a week job to pay for school and expenses.	connection between a future career and doing something he's extremely interested in while gaining fulfillment from helping others.

Career Tracks Connected to Motivation & Identity

In terms of career tracks within the world of engineering, it seems that although the majority of these students have had access to internships and co-ops within the industry, they don't know very much about the daily practice of roles like product manager and technical lead, and this is a pity because a number of these roles require good communicators and leaders, in addition to technical proficiency, and these are qualities that the students in this analysis have. Although from a parallel field, when we also take into account recent research that shows that a principal reason for URM attrition from the premedical pipeline is a loss in interest, specifically after taking courses in Chemistry (Gonzalez, 2010; Barr, Gonzalez, & Wanat, 2008), we can see what an important role one's understanding of specific careers in engineering might be. Some of these students struggle with where they fit into the world of engineering, and these alternative roles are well aligned with their identities and interests. There is a good chance that understanding some of the qualities of these roles, while these students were enrolled at UPri, would have helped them reach a more effective level of attainment as they pursued these degrees.

Gender

The female engineering students interviewed are well aware of the imbalance in gender

in the department, one explaining that she was one of two women in one of her courses. Added to the challenges brought on by this underrepresentation is the fact this gender imbalance is not aligned with the gender demographics on campus. One student described her transition into the first year of school as very jarring, when she could see a large number of women present on the *Yard*, and next to none in her department and her classes. And the way that the female students describe this underrepresentation also comes down to the foundations of the department. It might seem like a small thing to some, but the fact that there are fewer bathrooms in the engineering building for women is very telling. Women were not actually considered when the department was formed or the building was being built, because women were not supposed to be there, other than for brief visits or for administrative roles. The fact that the women in this analysis are thinking about it to that level of detail is telling as well. What message does this express to someone that already knows she is a minority in the department and can expect to be a minority going forward into the industry? Gender problems can translate into men that brazenly show their egos, and challenge women in class and on project work. For example, Roxanne states "some dudes have this thing like you know I know what I'm doing, especially when you're building something like I know what I'm doing so they kinda try to push you to the back, but you gotta be real aggressive when you're a woman, yeah." She goes on to state "Well I experienced some dudes who thought you know they knew more than me just because I don't know they had that ego type of thing." These men are portrayed as believing they know more than the women and therefore work to dominate the conversation. Additionally, it is noteworthy that only the women in this study recognized that gender discrimination exists at UPri.

Faculty, Administration & Courses

There were many comments on the role of faculty. Some professors are viewed as being

too intellectual and do not know how to teach to what Roxanne called common people, so being able to back off of the theoretical concepts in and of themselves, and instead apply that theory to something that is more accessible, tangible, and digestible might benefit these students. Some professors within the department of engineering are amazingly supportive, in holding test reviews until midnight at the library on their own time, to be sure that their students are getting the concepts and have their best chance to perform well on tests. Additionally, there are clearly courses that are deemed -make it or break it- in the department and in the prerequisite departments. These courses are assessed by the students as unreasonably difficult, and students recognize that some professors mistakenly equate difficulty with learning. Classes that are deemed by groups of students as impassable, are deemed that way not because of their content, but instead because the professor that is teaching it has set up the class in an inaccessible way. This harkens back to Seymour & Hewitt's data analysis, in which they found in all the groups they sampled, discouragement from poor teaching structures, the weed-out mentality, baked into the school's culture, and a level of indifference, which students regularly faced from their professors (Seymour & Hewitt, 1997).

Additionally, students believe that the university has made a mistake in seeking professors that are proficient in research and generating money for the school, rather than seeking educators that are also proficient at teaching and facilitating student learning. A number of students also noted a need for hands-on exposure to what the practice of engineering is, and introductory courses that explain what it is like to be an engineer in industry or in research, and that these courses should be offered either before or in line with prerequisite classes to give students a better understanding of what they can expect, rather than having to wait until they've advanced to junior or senior year, or wait until they are searching for jobs in the industry. Parallel to some of these needs is also a need for better advising and more resources so that advisors are able to do their jobs

effectively. A number of students spoke about mistakes that they or their advisors made related to registering for required classes. The best explanation that a few students gave was that their advisors were overtaxed with teaching, research, and in some cases full time work in the engineering industry. To that end, many students referenced leveraging classmates and upperclassmen within their social networks to get advice on which professors to take and when.

Classes seem to be more defined by the student's perception of the professor than by the course content itself. This advice applied to some of the students' references to -make it or break it- courses, or courses taught in a way in which they believed their professors were equating difficulty with learning. Essentially, students got advice on how difficult and how useful these professors' iterations on the required classes had turned out to be for their past students. The students interviewed were specifically looking for what to avoid and the best course of action to take in terms of class choices, to be successful in their programs. Interestingly, I have not yet noted one student that expressed the idea that they wanted to emulate their professors in their practice of engineering.

Opposition of Identity and Motivation Values

Attainment and identity values can oppose one another as we see in Sanaa and Monica's cases. Sanaa does not agree with her friend's definition of Sanaa's identity as someone obsessed with math. Sanaa sees herself as someone that has worked hard to succeed in these subjects, rather than as a person that was born with technical knowledge. This opposes Sanna's perspective of herself as someone that has the inherent attributes of an engineer. Monica on the other hand sees herself a strong leader and communicator, but does not connect these attributes to being an engineer. Attainment in these cases could be a reason for pursuing (or not pursuing) engineering that is related to being the type of

person that is an engineer. Both of these students' identities oppose that attainment.

This opposition can also make it very easy for a student to rest on their laurels, rather than pursuing fields that might be outside of their wheelhouses. This actually seems to oppose one of the most foundational assumptions around higher learning in the U.S., which is that students go to college to pursue something that they might not yet be good at, or something that they have not had exposure to, and therefore know nothing about. Myesha, for example, recognized that she does not have skills in problem solving, math or science, but intentionally chose to come to UPri to pursue an engineering degree and career, to actually learn how to attain the qualities and skills that an engineer has. Myesha had a great deal of stress over not coming into her major with a clear decision about whether or not she'd ultimately want to study engineering. So it seems that for some students, there is not very much space and time to explore what they will be most fulfilled by.

Some skills were not overtly equated with engineering, for example Monica enjoying leadership and communication, and Roxanne enjoying working with her hands, and practicing electrical engineering. There was also wide recognition that communication is a necessary skill for an engineering student and engineer's daily practice of engineering, but there was not very much prioritization of the skill as an attainment value, i.e. statements like "I am a good communicator, engineers are good communicators so therefore I would make a good engineer". This is an area that calls for further research, that could possibly have an impact on Engineering professor training and development. When it came to utility, the idea of doing engineering to make enough money to ultimately practice something else as a career came up a couple times, while the majority of students viewed the engineering field as a way to get a job and generate income. Additionally, it seemed that only one student was clearly assured that an engineering

degree would provide them with a life fulfilling career path.

Race

Students recognize that UPri is a competitive university, and that its ratings play a big role in they and their classmates' being sought after by technology companies. Multiple students noted that races other than the Black race are well prepared by their universities to succeed in the field of engineering. At the same time, the conundrum of being a Black woman or man in the industry also creates an environment in which companies supposedly seek out people from these backgrounds as those people are currently underrepresented, so many of these students feel they have a very good chance of being selected for these jobs. The problem is that once these students have entered a company as an intern or employee, they continue to be the minority there, as there are still few Black people making up these companies' ranks. Students with some experience in industry through internships or co-ops feel like their work is often more harshly scrutinized due to some combination of their race, nationality, and gender, feeling as though they always have to work much harder than others to prove that they are worthy of the position that they are in. This appears to go beyond what might be a more commonly held feeling of being an impostor, and instead be a disheartening consequence of institutional racism and sexism. There's an impression that these students feel like they are being judged as less than, due to their race and sex. It's a conundrum for these students to feel that they are both sought after by companies, while they also never really feel like they can relax into a position because their work and experience is always being questioned. Additionally, the students that come from Black american backgrounds are looking for an environment in which they can see other successful examples or representatives from their specific background, in addition to successful members of the wider african diaspora that they see at UPri.

Student Learning

Some students seem to embody a fixed mindset in which they do not think that they will be able to get better at math and science (Dweck, 2012). Many students noted the need to take control of their own learning rather than remain passive learners dependent on instructors for their success. In line with this notion, some students also noted that the more effective professors would regularly ask their students applicable practice questions during lecture, then have them vote on answers and engage them in further class discussion around their thinking and understanding of the concepts. Multiple students made statements about experiencing growing pains while transitioning into college, between first and second years, as well as into third year where they were finally getting access to electives, more engineering-heavy courses, and the professors that taught those courses. It is common for students entering college to begin by focusing on one area of study, and then ultimately change that major focus sometime around their junior year. This change is more common among students' whose intended major is in the STEM fields, and even more common among URM students, than among non-minority students (Griffiths, 2010, National Science Board, 2007). We see evidence of the challenges that surround this transitional point in these students' stories as well. A number of students noted strategies to get extra credit points and extra help from professors to succeed at passing courses that were otherwise challenging. It seems very difficult for students to come from a poor performing high school, where they might have been at the top of their class, to then find it a struggle transitioning into a college full of more competitive classmates. It must be very challenging to find that you were not well prepared for college, during your secondary school experience. Multiple students noted the importance of being what they called *well-rounded*. In some instances, this applied to also being good in the humanities, i.e., being skilled at writing. Others equated being *well-rounded*

with having past times outside of engineering, and the opportunity to be social, go out on weekends, and have fun, rather than being cooped up in the engineering lab at all hours.

International & Domestic Experience

Black international students were defined as elite, and one interviewee described these groups as inculcated in their culture, only sharing within that culture during study groups. These international students are also described as older and more experienced, having worked in industry and having completed additional coursework to qualify to enter the U.S. to study. Some Black american students felt under resourced, and outmatched by Black international students. Additionally, in some cases, Black students felt outnumbered or underrepresented, while also being culturally barred from international groups due to cultural differences. Students from both groups in this analysis laid out evidence that they recognized engineering at UPri was not set up fairly among all groups, due to some secondary school differences between the U.S. and the Caribbean islands. By these accounts, the international students appear to be much more well armed at getting through the challenging academics of engineering at UPri. This raises the question, could there be some degree of stereotype threat felt among Black students when they consider the experience, knowledge, and cultural differences they notice when they are compared to Black international students?

Additionally, some of these experiences align with an earlier point in this analysis, which noted the findings by Griffith, et al. (2010) where the researchers examined which factors contribute to the academic persistence of women and minorities in STEM field majors. Griffith, et al. (2010) found that at selective institutions with higher graduate to undergraduate student ratios, as well as institutions that invest in higher amounts of spending on research, the institutions end up with URM and female students with lower

persistence rates in the STEM fields (Griffith, 2010). I would hypothesize that programs that cater to more experienced and resourced international students, may have some of the same qualities that schools with a higher graduate to undergraduate student ratio have. This observation also leads one to weigh the multiple references made by students to poor advising, which many of the students viewed as being due to their professors being overtaxed by the research requirements of their faculty positions. This interpretation clearly connects with Griffith et al.'s findings that lower URM persistence rates are correlated with institutions that have a higher level of spending on research (Griffith, 2010).

High Cost of Pursuing the Engineering Degree

Last, but still very significant is the insight that students seem to believe that the degree of sleep deprivation, stress, and depression that they undergo, is actually the norm for engineering, essentially that it's a given that to be an engineer you simply must suffer through this type of experience.

Conclusions and Connections to Research Questions

Research Question 1

How do URM students think about and attach meaning to their experiences in introductory STEM courses? The initial exploration was focused on how URM students think about and attach meaning to their experiences in introductory STEM courses. Many of the students in this analysis referenced their experiences in their first and second year courses in computer engineering, computer science, and electrical engineering. Much of

the way these students conceptualized their performance in these courses, and the role that their performance played in their perceptions of themselves as future engineers, was tied to their past experiences in the field prior to college at UPri. Both U.S. and international students had space in the interviews to reference their high school experiences, and as stated, some U.S. students noted poor preparation in math and science from their high schools, while some international students noted that their high school curriculum was superior to that offered in the U.S, explicitly stating as much. This past experience played a large role in how well students felt they were performing in their UPri courses, and the engineering program overall. Students that expressed either skill or lack of skill in math, science, and problem solving, also tied these skills to both their identity, i.e. *I'm not the smart when it comes to math*, and their attainment values, i.e. *I'm not good at solving problems and an engineer is good at solving problems.*

All of these students identified as Black, African American, and/or Trinidadian, and these racial and ethnic identities played into their experience with their coursework, as well as their perception of their potential future careers in different ways. The most obvious way that race played a role was the different interpretations that students had as to how well or poorly international students versus U.S. students might have been prepared during secondary school. Many of the Black students from the U.S. noted that they enjoyed the fact that at UPri they had the opportunity to see a large population of other academically successful black people around them, as this might not have been the case for them in high school, some students either attending majority white schools, or some students attending schools where they felt that other students around them were not as academically successful, regardless of race.

Gender played a role for female students as they noted that they were the minority in the engineering department, but this was not the case on campus overall for them. Some

female students felt talked over and dominated by male students during conversations in engineering classes and conversations around group projects. Identifying as social or not social was also a very common thread across student interviews, many students referencing the fact that non-engineers perceived the students in this analysis as non-sociable, due solely to the fact that they were engineers. Many students pushed back on this definition, and either portrayed themselves as outliers in the engineering field due to the fact that they were sociable, referenced the idea that one of the major costs of being an engineering student was that their social lives and down-time were extremely hindered by their school responsibilities, or referenced the idea that they worked to be more social, calling this work a pursuit of being more *well-rounded* in their school experience and lives in general.

Research Question 2

How do student perceptions of their own learning experiences (those organized by the university itself like courses, those created by cultural norms of the university like study groups, and those created in partnership by the university and outside companies like internships and coops) play into the students' persistence in their major? These student's perceptions of their learning experiences played into both their persistence in the major as well as their perceptions of their potential future careers inside and outside of engineering. Within courses, labs, study groups, as well as outside of courses in internships, and co-ops these students found success in some learning formats, as well as challenges to their performance and their learning in other formats. Some of the things helping student performance were dedicated professors that would stay with them in the library until midnight the night before a test, to help the students prepare during a study group. Additionally students found success by trying different iterations of their time management plans to get work done, while also including time for relaxation and sleep. It also seems that hands on work and practice either during internships, co-ops or doing

independent work to fix roommates' computers, facilitated their learning and practice of engineering.

Some of the things that are hindering their performance are, the sheer depth of the course requirements of being an engineering major, which translated into an extreme lack of time for sleep, as well as fitting what some seemed to consider a five year course load, into four years. Additionally, students' perceptions that their advisors were not effective, seemed to be a major hindrance, as students noted having little access to advisors that were also over-committed with faculty, research, and industry work weighing them down. This lack of advising translated to some students taking the wrong classes, those classes that did not successfully fulfill their course requirements, and taking multiple different courses for one requirement, creating a redundancy that students saw as very costly in a program that has many course requirements. This only added to their negative perceptions of what they saw as a heavy course load from semester to semester, and an extended stay at UPri, that could go well beyond four years.

Research Question 3

What do students suggest would make the student learning experience better for them and others? When it came to questions about what might facilitate or hinder long term internalization of class content and engineering practices, students' suggestions were mainly focused on course design. When it came to course design the most common reference made was to the modification or avoidance of what some referred to as *make it or break it* or *gatekeeper* classes. Students also spoke about the challenges they'd noticed when professors equated difficulty with learning. The problem with the design and execution of these classes was ascribed directly to the professors themselves, as they were seen as making poor pedagogical decisions, and some onus was laid on the school

administration for originally choosing professors that, although adept at carrying out research were not effective teachers. Students also noted an improved learning experience when professors designed feedback into lectures and labs, where they would ask the students to practice a concept just taught in class by solving an applicable problem. The professors would then solicit answers from students to generate additional discussion and practice around that concept for more effective understanding.

When it came to resources outside of those provided by the course itself, every student referenced the use of classmates and more senior students for advice, specifically on which classes were deemed *make it or break it* courses, and which professors were the best or worst professors to take specific required courses with. Some parsed this advice down to which classes and professors were the best to take if the student's performance in the course was the highest priority, i.e. *which course or professor can I get the best grade from*, versus which course or professor is the best choice for my learning and internalization of the topics covered, i.e. *even if the course is difficult and I'm not able to achieve a high grade, which choice will insure that I really understand the content.* This last level of analysis of courses by the students was especially important for course sequences like the three semesters of calculus that students were taking, as well as the connections between the principles of calculus and the principles of physics, and how the two course sequences relied upon one another in terms of content covered. For example for one student, a lesser grade in calculus coupled with a better understanding of the foundational concepts, was a clear priority when it came to succeeding in the rest of the courses in the sequence, as well as the rest of the courses in the physics sequence.

When it came to plans and strategies for dealing with future classes, this leveraging of upperclassman was extremely important as well, and many students noted a division between the courses covered freshman and sophomore years, versus the elective courses

and more engineering focused courses that they began taking in their junior year. Interestingly, this transition to becoming an upperclassmen was a challenge for students in that, not only did they not know what to expect in these upper division classes, but also for many, this was their first introduction to what they then began to think, engineering was really ultimately about. Even further interesting is the distinction that some students made between all of this classwork, and the actual practice of engineering in the field that they began to see during co-op and internship opportunities, i.e. Roxanne referenced the idea that if it had not been for her co-op time and internship, she felt that the engineering program would not have adequately prepared her to go into the industry once she'd graduated.

There were also a few references to the differences between students that remained on the path to an engineering degree, and therefore remained in the pipeline to reach their ultimate career goal, and those students that dropped out part way through their degree process. The distinction that was made here by some of the students was in reference to international students versus students that were from the U.S. In addition to better secondary school preparation had by many international students, those international students were also portrayed by both themselves and by U.S. students as being more focused and devoted to the end goal of an engineering career. References were made to international students actually coming back from industry jobs to pursue their degree in engineering at UPri, this experience giving those students a greater degree of focus on their programs. Additionally students referenced the older age of many international students, as well as their need to maintain a strong grade point average to retain scholarships and advance toward graduation, as facets of their experience that kept them more focused and devoted to finishing the degree, and in some cases re-enter the engineering workforce. These descriptions were then opposed to perceptions that U.S. students are sometimes less prepared, and less focused on their goals, as they had come

from high schools that did not give them the curricular background necessary to succeed, as well as the fact that they might still embody the mentality of continuously searching for what they really want to do in life, not being entirely sure that engineering is the right thing for them. We see this in Myesha's case as well when she wrestles with whether or not she should actually study engineering, or should instead follow an educational track into language studies.

Major Insights

The two most salient points that arose from this analysis are centered around perceptions related to attainment and identity. When it comes to attainment, students described their beliefs about the attributes of a good engineer. Some described the ways in which their professors might define a good engineer, agreeing that engineers had to be good problem solvers, and good at math and science. Some students saw themselves as having these attributes and others did not. In all cases, though, students described strong attributes that they themselves held, like being sociable, being a good communicator, being able to lead and manage others, being dedicated to work and study to the extent that you would sacrifice time, sleep, relationships, and one's well being. But it seems that no one volunteered these latter attributes as the qualities that were also necessary to be a good engineer. In one case, for example, Monica presented evidence of wonderful management and communication skills, but did not believe that these would make her a good engineer, let alone recognize that in industry and research, good communication and leadership are necessities for engineers. Something within the institutional culture of UPri at the time, might have caused faculty and administrators to miss this opportunity to highlight these skills as necessary attributes of a good engineer. As so many of these students identified with these qualities, it would be useful to help them understand that although they might not be the best problem solvers or mathematicians (by their own standards), there is

however, a place in the world of engineering for the skills they do possess. Hopefully current and future students at UPri and other universities can say, engineers are adept at communication, I am a good communicator, therefore I can see myself as an engineer.

Additionally, it was surprising to find data on the existence of two subgroups within this batch of case studies, that is Black american students and Caribbean or African international students. Students from both of these backgrounds noted that the secondary school system in the Caribbean was far superior to the public secondary school system in the U.S. Black american students in this group recognized that many of the Caribbean international students came into UPri at an older age, with advanced classes, and some engineering career work under their belts. No matter how well each of these students was performing in class they recognized that there was something of an unlevel playing field within the department of engineering at UPri between these groups. One particular Black american student, Myesha pointed out that she actually struggled to break into international student study groups, but had trouble entering, as everyone in a group like this but her, had some shared cultural understanding, and therefore Myesha felt that she did not belong. Another Black american student racked his brain to think of one other student that was also Black and from the U.S. in his cohort, but could not, recognizing that the majority of his cohort was made up of international students from the Caribbean. We find here an extra challenge for Black american students at UPri. While Black people in general are a minority in university engineering departments and in the engineering industry, the Black american students at UPri find that even within a Historically Black College & University they remain the minority.

Some of these Black american students have noted their poor math and science preparation in high school. Being an underrepresented minority alone presents the possibility of stereotype threat (Steele, 1995). It seems that in these instances, even when

one is surrounded by others that share their same race, she can still be the minority, and there's a very good chance that students like this are experiencing stereotype threat around groups of students that share their race, but not their cultural background, national history, or the shortcomings of their public school systems. Identifying as Black even at an HBCU has the potential to cause stereotype threat for these students. How then might the university and others like it, recognize these different demographic subgroups and the challenges that students can face when their specific culture, as well as educational background, are not well represented and their learning needs are not understood? Universities and other educational institutions should recognize the existence of these different groups and try to build a recruitment and retention infrastructure, as well as a systematic way to design curriculum that supports students from these multiple backgrounds, instead of believing that students of one race also have the same educational backgrounds and learning needs.

Reflecting on my originally proposed research questions, I find that many of them were fruitful. I was able to uncover new dimensions of the experience of URM students in introductory Computer Science and Engineering courses. Although the majority of these students have had access to internships and co-ops within the industry, they don't know very much about the daily practice of roles like product manager and technical lead, a pity as a number of these roles require good communicators and leaders, qualities that the students in this analysis have. When it comes to how these students conceptualize their performance in courses, and the role that performance plays in their perception of themselves as future engineers, many of these students seem to have an interpretation of their engineering capacity that does not jibe with traditional faculty and researcher definitions of what it means to be a qualified engineer. These are perceptions of performing in class versus in the field, and the misinterpretation that good communication skills are not aligned with successful engineering practice. Future work

should more systematically drill into the specific differences between URM student perception of the qualities necessary to be an engineer, versus those parallel perceptions held by students from majority groups in engineering.

When it came to the impact of a URM identity on students' experience in school, I found an additional degree of identification within the URM Black student group, as students identified with Black American, African, and Caribbean groups within the department. These groups connected and communicated within courses in very different ways due to what they saw as vast differences in experience. This work touched on class structure, group project work, co-ops & internships, as well as major course sequence and degree structure. However, the data from these qualitative interviews was not structured to lend itself to an analysis of direct comparison across students on course curriculum, or project work, for example. Future work that compares student perceptions of specific learning objects will go a long way in assessing the efficacy of course structure in schools like UPri, other HBCUS, HSIs, Native American serving institutions, and more traditional institutions to get researchers closer to understanding what best supports URM students and prepares them for careers in the fields of engineering.

While not much was shared about perceptions of students that stepped off of the path of studying engineering, students in this analysis were very forthcoming about the aspects of their learning experience that helped or hindered them, i.e. professors that spent late nights in library study halls, versus professors that believed that greater course difficulty equated with a greater degree of learning. Much was said about the resiliency of advanced students (juniors and seniors) and the role of support and knowledge providers that they played, while counselors and advisors were perceived to have dropped the ball on providing good guidance, due to what the students perceived as their counselors being overtasked and overworked. A more systematic review of counseling services as well as

student community groups, and a comparison between HBCUs and more traditional universities would provide a great deal more actionable data for university administrators tasked with providing this much needed support for their students.

Lastly, another major area of work, which this analysis brought forward for potential future study is an exploration of the difference in experience between a student entering college, already decided on a computer science related major, and a student that enters, still exploring what might be the best track for her. In this analysis there was a stark difference in the experiences of students from those two groups. Future research on what data points might best predict whether or not an entering student stays on track with their major choice, might impact the program design that HBCU and more traditional universities choose to implement, i.e. an advisory track for students that have a high probability of remaining on track, versus an alternative track for students that are still exploring what major they believe best fits them, as well as an ability to change from one advisory track to the other if a substantial motivation or attainment shift takes place.

My overarching question with this work was 'how might we explore the experience of URMs on the engineering pathway to better understand their motivations and the challenges they face?' While there is a clear lack of URMs in STEM, more specifically in Computer Science, the people currently practicing the role of computer scientist are designing and building products that have massive global impact. For that reason, principles of inclusivity in this field are just as important as they are in fields like Medicine. The pipeline to Computer Science careers is long, but undergraduate education is an important branch point for educational researchers to explore, and very little current research has been published on the details of the Black engineering undergraduate experience. One implication of my analysis is that educational institutions are missing an opportunity to leverage student identity and attainment values to showcase specific career

tracks, and the components of those tracks that fit with the student's identity and interests. There are unique learning backgrounds that exist within the URM Black population that need to be better characterized, and ultimately leveraged by faculty and advisors, to better design major programs and class curricula that tie students to potential career goals. For example, Monica challenges us to think more broadly about what attributes can be equated with being an engineer. Skilled at the more traditional definitions of what it means to be an engineer, she also is highly skilled at communicating and leading engineering student teams to execute on implementation, but she does not equate those attributes with engineering. And Roxanne sees the work of an engineering student as limiting her ability to build deep and substantial relationships with others, as she is always unavailable to socialize with her friends and grow those friendships due to the incessant engineering work that she has. How might educational institutions surface relevant competencies like leadership and communication skills, and how might they assess those during required courses. We need to make more transparent what engineering careers look like, to support a diverse array of career imaginings for students from these underrepresented backgrounds and others, and we need to both recognize and validate the sacrifices that students are making to pursue these paths as they are not small sacrifices. A student's ability to devote herself to her craft, and sacrifice social relationships for her ultimate career, might not be the qualities a university should source for when recruiting potential candidates. At the same time, this devotion and sacrifice is a reality for students and therefore, should not be ignored. If this is what students are putting up with on a daily basis, faculty and other administrators need to either design a more supportive and healthy environment within their courses, or design a stronger formal support system to help these students follow these paths.

Matusovich et al.'s model also make a distinction between the the costs of being a practicing engineer, and the costs of being an engineering student (Matusovich et al.,

2010). To the researchers, the "heavy course loads or the emotional and psychological toll associated with the financial burden of paying for engineering courses" are less important than the costs that might be associated with the work-life balance of a practicing engineer (Matusovich et al., 2010, p. 297). Matusovich et al., could not distinguish between data that describes the cost of studying engineering from the cost of studying another major at a competitive college or university. And this is limiting for two reasons. Firstly, many of the students interviewed, spoke to challenges that were directly related to being an engineering student, and distinguished these challenges from either their experience in other non-engineering classes, or the experiences of their peers in these non-engineering classes and major-related cultures, so the students recognize the importance of the costs related to being an engineering student. Secondly, because these students have only studied engineering rather than practiced it, they have a great deal more insight into what it means to be an engineering student than what it means to be in an engineer. Therefore this framework should be expanded to include challenges that are directly related to being an engineering student. Additionally the framework should also be expanded to not just include, but also prioritize engineering students' perspectives of what it means to be an engineering student rather than prioritize a less-experienced, arguably nieve, student-perspective of what it means to be an engineer.

Additionally for this small group of students (and I would hypothesize that this is true for a larger swath of students as well) some of these values or sets of values oppose each other, i.e. attainment can affect identity, and vice versa. Additionally, career tracks as they are explored during the degree program need to be displayed more clearly, as well as connected to student values of attainment and identity. From the student perspective, the women in this group felt they had little representation in their department and were treated as an afterthought in some cases. Students of all genders in these cases saw their racial background as something that was both sought after and stereotyped by industry, as

they interacted with company employees and recruiters during internships and co-op placements. The analysis highlighted strong differences in the experience of international vs. domestic Black students at UPri, as the two groups were viewed by one another (in these cases) as having profoundly different experiences prior to and during the university program. Additionally, this work has highlighted themes of resilience and the leveraging of resources like upperclassmen. Students at UPri describe a harrowing student life in which they sacrifice sleep, relationships, and a great deal of effort to pursue degrees, and ultimately careers that many of them do not yet fully understand the details of. They use the community of senior students, class year peers, family and faculty to do all they can to remain on course and perform competitively. Having a clearer picture of what sacrifices need to be made as an engineering student, push the Matusovich et al. framework further, emphasizing the importance of the effort and sacrifice that many URM students must contribute to stay the course.

As there are many challenges that students might possibly face on the road to completing an engineering degree and beginning a career in the field, an equally important and complementary line of research to explore, is what might possibly better engage students in the engineering craft. To address this question more generally, Acevedo focused on an interest-based pursuit of amateur astronomy, describing 4 structural and process features of astronomy practice, affording individuals practice of the hobby (Acevedo, 2013).

Two of Acevedo's astronomy practice features seemed to apply to the experience of a number of these UPri students, one of which was *material infrastructure*, what he called the "sum total of all material aspects of the hobby, including the categories equipment (telescopes, etc.), literature, charts and atlases… among many others" (Acevedo, 2013, p. 491). Rorke was a fantastic example of this feature of the practice of hobby, in this case his ability to deconstruct and reconstruct a computer, troubleshoot and do contract, information technology work on the side, to help fellow classmates and friends while also studying his craft more formally in the UPri program. The fourth of Acevedo's features is

the *process of collaboration and idea sharing*, which he describes as "the ongoing community help an astronomer receives in carrying out his or her multiple observational goals… critical to sustaining work along chosen, tailored trajectories" (Acevedo, 2013, p. 496).

The process of collaboration reminds us firstly, of Monica's skill in leadership, communication, and collaboration, but more importantly reminds us of the adaptive process that nearly all of the students in the UPri analysis used to make it through harrowing courses; that was leaning on peer classmates and senior students for guidance, help, and support. In this case, Acevedo references astronomers spending long nights using systematic methods of observation, as they relied on one another for their expertise and their access to their peers' tools and practices, reminding us of the late nights spent in lab and the library that UPri students had to commit to their success in their coursework. Future work that focuses on highlighting the positive and beneficial aspects of the tools which students leverage for continued success in undergraduate engineering courses will most likely prove just as beneficial as an exploration of what is most challenging to these students. Acevedo explains that "being interested in a practice requires weaving it with many other concerns, domains, values, goals, and practices in one's life" (Acevedo, 2013, p. 505). And when it comes to designing "environments for interest-driven science and mathematics learning, instructional designers must proceed from a somewhat different basis and set of assumptions", in this case, one that leverages or amplifies the aspects of engineering that students are most interested in practicing (Acevedo, 2013, p. 505).

Maldonado in her 2016 dissertation also stresses that "collaborative groups score higher in motivation and valuing of the subjects learned than individuals" (Nichols & Miller,

1994; Springer, Donovan, & Stanne, 1999) (Maldonado, 2016, p.92). Costley & Lange, (2018) also found that while all students in their study of online-course, group-work collaboration "benefited from group work, students with lower levels of motivation benefited more than students with high levels of motivation… showing the value this type of group work can have for all learners, particularly those who may otherwise struggle" (Costley, J. & Lange, C., 2018, p. 68). Although this was research focused on online work, some of the threads of collaboration that ran through the cases in the UPri analysis might also ultimately have had an effect on each of the students' levels of motivation to pursue a degree in engineering, especially while shouldering the high degree of dedication to their work and the stress levels these students experienced.

Limitations of the Study

As this study is case-based, the intention was to seek out qualitative insights that might be further studied with different methods on a larger sample, in hope of ultimately finding data generalizable to a larger population. At the same time this exploration of the experience of URM students in engineering has to start somewhere. As the APS data analysis has not yet represented the experience of URM students, starting with qualitative insights such as these might ultimately support future research that has far reaching impact on the design of an engineering education that is supportive of the needs of student groups that have not yet been made the priority of educational institutions. The limitations of the study, as well as the intentions of the study in a way, go hand in hand.

The analysis solely focused on Black engineering students that were attending an HBCU. While targeting such a school and such a group is useful, it is also a very specific experience that I've attempted to characterize. The experience of Black students attending a minority serving institution like UPri, does not necessarily represent the experience of Black students attending universities where they are the racial/ethnic

minority. Additionally, UPri is a private university with a competitive application process which neither represents the majority of HBCUs nor represents the institutions that serve the Black college-age population of the U.S. Therefore, in addition to building on this research by applying more quantitative methods with larger sample sizes, the participants and the data that one sources for these studies should also come from higher-learning institutions that are more representative of the wider Black engineering student population. Case studies carried out on students attending public and private, HBCU and non-HBCU universities would be a good start as a comparison point. Further comparison would entail talking with or analyzing data from students that are not Black, yet attending an HBCU, as well as groups of students that are Black and others that are not Black, attending the wider array of universities mentioned. In essence future research needs to compare a diverse array of students at a diverse array of universities, to ultimately get a clearer understanding of how to design engineering programs that support each of these groups of students for success in both program completion, and the pursuit of engineering careers.

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