UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

INDIGENIZING THE ACADEMY: A STORY-TELLING JOURNEY TO DETERMINE PATHWAYS FOR NATIVE STUDENT SUCCESS IN ENGINEERING

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

TIFFANY DIANE SMITH
Norman, Oklahoma
2019

INDIGENIZING THE ACADEMY: A STORY-TELLING JOURNEY TO DETERMINE PATHWAYS FOR NATIVE STUDENT SUCCESS IN ENGINEERING

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF
EDUCATIONAL LEADERSHIP AND POLICY STUDIES

BY THE COMMITTEE CONSISTING OF

Dr. Derek Houston, Chair

Dr. Heather Shotton

Dr. Sabina Vaught

Dr. Mirelsie Velazquez

Dr. Kirsten Williams

ACKNOWLEDGEMENTS

Many individuals have supported my dissertation journey. I would like to take a moment to express my immense gratitude for those who have made invaluable contributions to my completing this process.

To my ancestors:

Wado for all of your guidance and for paving pathways so that I, and other Indigenous scholars, have been able to find our place and purpose in this life. I stand on your shoulders, as you have created opportunities that would not have existed without your struggle and resilience. Thank you to my grandparents, though you are not here physically, I always felt your spiritual presence and support and I dedicate this dissertation to you.

To my family:

Zach, my life partner, while I know this has been challenging for you almost just as much as it was for me, I am grateful for your strong partnership in pushing me to get this important work complete and for making the sacrifices necessary to allow me to do so. You offered me love, motivation, and had to pick up more than your fair share of child-care activities to allow me to finish. You are my rock. I love you.

Tytan, just as your name means "strength," you have been nothing short but that strength for me throughout this journey. You joined our family in the midst of my doctoral journey, but you were my inspiration for my returning to school after my leave of absence and sticking to it. Being your mommy is life's greatest gift. Your smile and energy are infectious, and can cheer me up on my toughest day. Wherever life takes you, I hope I am able to inspire you to persist through the challenges and attain your wildest dreams. I love you to infinity and beyond, always and forever.

Mya, my unborn child, who has been along for the ride these last 7 months of my journey, I hope mommy's story will inspire you to pursue your dreams one day. I hope this will give you hope that you can achieve all you want to achieve in life with persistence and support from your family and community. Growing you inside of me has given me more motivation and strength to keep going to the end, knowing that you and your brother are a part of the future of Indian Country. I love you to infinity and beyond, always and forever. Cannot wait to meet you soon.

My mother, Diane, you are the one who encouraged me to keep pushing through school. Even when I had my doubts, you always inspired me with your relentless passion for giving of yourself for others. You raised me and Ryan to be unafraid to pursue our passions, and made sacrifices to ensure we could. Your undying love for us, and now for your grandchildren, have provided the support I needed to succeed. My success is your success. I love you.

My father, Charles, you have always been one of my biggest cheerleaders, and always pushed me to be better. You emulate hard work and persistence. Your encouraging words of support have always meant so much and helped me to keep pushing through tough times. You have always believed in me when I didn't always believe in myself. For that, I am forever grateful. I love you.

To my committee:

Dr. Mellie Velazquez, you were the first professor to believe in my ability to teach. I will never forget your Race and Education in Oklahoma course, as it truly impacted my life in transformative ways. You were there when I needed you and gave sound advice on how to support those I cared about most. You are a strong Latina woman, mother, and badass scholar that I look up to dearly. Appreciate your continued support.

Dr. Kirsten Edwards Williams, I have always been astounded and intimidated by your brilliance. Your Religious and Spiritual Diversity course was one of my most memorable classroom experiences. It challenged me to think in new ways. I appreciate your support throughout my journey, and for challenging me to think on a deeper and more critical level.

Dr. Sabina Vaught, I am so grateful you joined as our new leader of the EDAH department in time for my forming my committee. Not only have you transformed the culture of the department in just one year, you truly focused on inclusivity and elevating our Indigenous presence and allowing us to be heard. Additionally, you are selfless and giving of your time to have helped me with edits and thinking more critically with my work. I value the true sense of community and space you have allowed for me, and others like me, to have in this department.

Dr. Derek Houston, you came on as my advisor late in the game…right in my final and most critical year. You were just what I needed at the right time, and I am so grateful of how you are the most authentic and caring individual, who makes your students feel like family. You have always had my back and advocated for my finishing, and I know I would not have done so without your support. We DID it!

Dr. Heather Shotton, though you are not formally my chair, you undoubtedly deserve the "co-chair" title here. Without your support, I definitely would not be here finishing. You went way above and beyond to not only in helping us create an Indigenous cohort in the program, but you were like our auntie always watching out for us. You have made many sacrifices of your time for me, of which I have always recognized and greatly appreciated beyond words. You encouraged my presenting at conferences collaboratively with my sisters and brothers, which helped with my confidence in my scholarly contributions. You have saved me time and time again – I owe you so much. I hope that finishing can be a big part of giving back for all you have done for me. You continue to keep me engaged and I am so blessed to know you and learn from you – such a strong, brilliant, and resilient badass Indigenous scholar and mother. You are my family and a true role model.

To my fellow Indigenous scholar family:

I would not have survived this process without each of you: Breanna, Monty, Corey, Emma, and Stephanie. Breanna, Monty and Corey, we were the sole four Natives in our program when I returned from my academic leave of absence. I felt so alone before I had you all in the program with me. You are my sister and brothers for life, and this is a bond and time in our lives I will never forget. Looking forward to our future collaborative contributions to the field.

To my IPKC family:

NASPA IPKC was the first community within a professional association that I felt I could truly call home. I am especially grateful to you, my sister-scholar, Dr. Charlotte Davidson. You

believed in me and brought me into the IPKC leadership team this last year in my doctoral program. This team provided me with a support group, and you particularly, would make time to schedule calls and check in on me. You have been the big sister I never had, and I am so grateful for our kinship and sisterhood bond that was formed so easily. Thank you for your loving guidance and wisdom shared to help me finish. I am forever grateful for your vulnerability and strength you shared with me, that empowered me to keep going.

To Dr. Penny Pasque:

You were the person who kept on me after the master's program to pursue the doctorate. As a first-generation student, I never thought this was possible for me to achieve. Your belief in my abilities and constant support encouraged me to apply and continue my education four years later. Though you were not formally my advisor, I considered you one. You helped me through many struggles along my journey, and I am forever grateful for your time, thoughtful wisdom, and genuine love and encouragement you showed me. I am here finishing partly because of you. I will never forget your generosity, and I consider you family and someone I admire so much.

To the students:

Not only did you all inspire me to do this work, but you sparked more of a fire in me to continue through this process for the empowerment of our tribal communities. Thank you for giving of your time and stories to share your experiences to impact future generations of students, administrators and policymakers on our college campuses, and the resilience of our own sovereign nations. You have forever impacted my life, as well as countless others coming behind you.

To the future generations of Indigenous scholars:

You are the future of Indian Country, and with each generation, our lights shine brighter and stronger than before. I hope this collective work shows you what can be accomplished with much love, labor, and working in community with and for your people. Continue this work and add to it to increase our visibility and presence at mainstream institutions. You can accomplish anything and everything you set your mind to. We believe in you!

Wado/Mvto!

Table of Contents

Abstract xii
Chapter Sagwu (One): Introduction to the Study 1
My Story 1
Statement of the Problem 6
Purpose of the Study 10
Research Questions 10
Significance of Study 11
Diverse Nation 12
Federal Initatives 13
Native American Initiatives 16
STEM Attrition 18
Engineering Messaging 20
Summary of Significance 23
Outline of Dissertation 24
Chapter Tali (Two): Review of Literature 25
Introduction 25
History of Native American Education 27
Colonial Era 29
Federal Era 30
Self-Determination Era 31
Native Students in Higher Education 32
Barriers to Access 35
Persistence Factors 36
Students of Color in STEM 38
Holistic Support 39
Impact of TCUs 41
AIHEC STEM Initiatives 42
NSF Tribal Colleges and Universities Program 43
Chief Dull Knife College 45
Salish Kootenai College 46
Native Students in STEM 49
Table 2.1. Percentage Distribution of Engineering Bachelor's Degrees Awarded Compared to Total Bachelor's Degrees Conferred by Race/Ethnicity, 2014-15 50
Dissonance in Epistemologies 51
Communal Goals 53

Culturally Relevant Retention Theories 54
Theory of Transculturation 55
Family Education Model 56
Summary 57
Chapter Joi (Three): Methodology 60
Introduction 60
Research Questions 62
Conceptual Framework 63
Tribal Critical Race Theory 64
Indigenous Research Paradigm 68
Indigenous Storywork 71
Figure 3.1. Visual Representation of the Concept of Holism 72
Rationale for Methodological Approach 73
Researcher Positionality 75
Data Collection 77
Conversations 77
Conversation Format 78
Building Trust 79
Sampling 80
Additional Forms of Data 82
Reciprocity 83
Data Analysis 84
Interconnectedness in Students' Stories 84
Figure 3.2. Visual Concept Wall of Participants 86
Figure 3.3. Second Phase of Connecting Themes Visual 87
Figure 3.4. Utiyvhi (Balance) in Engineering Model 88
Limitations 88
Summary 89
Chapter Nvgi (Four): Stories of Engineering Students 91
Indigenous Engineering Students 92
Selection of Pseudonyms 93
Organization of Story 94
Figure 4.1. Cherokee Seven-Pointed Star: Pathways of Indigenous Engineering Students 95
Engineering Student #1: Quetzalli 95
Engineering Student #2: Xander 106
Engineering Student #3: Hank 110
Engineering Student #4: Bree 114
Engineering Student #5: Micah 118
Engineering Student #6: Josefina 124
Engineering Student #7: Marcus 131
Summary 135
Chapter Hisgi (Five): Findings 136

Figure 5.1. Utiyvhi in Engineering Model 137
Table 5.1. Engineering Student Demographics 137
Nurturing Early Connection to Engineering 138
Parental Encouragement for Education 138
Fascination with a Phenomenon 140
Math and Science Exposure and Preparation 143
Mentor Influence 144
College Visibility 146
High School Counselor Tracking 148
Utilizing Survivance to Conquer the "Hidden Curriculum" 149
Racism and Isolation 152
Negative Classroom Experiences 155
Building a "School Family" or Community 158
Native Support Programs 161
Faculty Relationships 164
Establishing Confidence through Experiential Learning 165
Internships or Other Work Experiences 166
Research and Lab Opportunities 167
Maintaining Cultural Identity to Achieve Utiyvhi (Balance) 170
Summary of Findings 174
Chapter Sudali (Six): Discussion & Implications for Policy and Practice 175
Creating Utiyvhi (Balance) for Indigenous Persistence in Engineering 175
Reflections on the Research Process 176
Revisiting the Four Lessons from Indigenous Students' Stories 179
Discussion 182
Tribal Critical Race Theory 183
Indigenous Research Paradigm 188
Relationship to Family 190
Relationship to Space and Place 191
Relationship to Identity and Community 192
Relationship to Engineering Discipline 193
Implications for Practice, Policy and Research 194
Practice 194
Nurturing Connection to Engineering at the K-12 Level 195
Building Community at the College Level 196
Policy 199
Research 201
Summary 202
References 205
Appendices 230

List of Tables

Table 2.1. Percentage Distribution of Engineering Bachelor's Degrees Awarded Compared to Total Bachelor's Degrees Conferred by Race/Ethnicity, 2014-15 50

Table 5.1. Engineering Student Demographics 137

List of Figures

Figure 3.1.	Visual Representation of the Concept of Holism	72
Figure 3.2.	Visual Concept Wall of Participants	86
Figure 3.3.	Second Phase of Connecting Themes Visual	87
Figure 3.4.	Utiyvhi (Balance) in Engineering Model	88
Figure 4.1.	Cherokee Seven-Pointed Star: Pathways of Indigenous Engineering Students	95
Figure 5.1.	Utiyvhi (Balance) in Engineering Model	137

Abstract

This study centers the experiences of Indigenous students persisting in undergraduate engineering programs at non-Native colleges and universities (NNCUs). With Native students having the lowest representation amongst all minoritized groups in higher education in general, and particularly in engineering, it is critically concerning that our perspective is not being well-represented. Native students are typically lumped together with other groups, which not only makes us feel insignificant and silenced, but attests to the low numbers of Indigenous students graduating with engineering degrees. Through the methodological approach of Indigenous Storywork, this study utilizes a series of conversations with seven self-identifying Indigenous students from various gender identities enrolled in undergraduate engineering programs, or who have graduated during the 2013-2018 time period, at four-year, public NNCUs across the nation. The study is theoretically conceptualized through the combination of Tribal Critical Race Theory and Indigenous Research Paradigm, leading to a model guided by the researcher's own Cherokee tribal epistemology and ontology. Findings included four major themes as a part of the Utiyvhi in Engineering model: Nurturing an Early Connection to Engineering, Utilizing Survivance to Conquer the "Hidden Curriculum," Building a "School Family" or Community, and Establishing Confidence through Experiential Learning. This study may inform administrators of successful strategies on how to be in a reciprocal relationship with tribal nations to recruit Indigenous students to their programs, provide culturally relevant and supportive environments for them, and ultimately graduate them to contribute to the workforce and the increased vitality of their respective tribal communities.

Keywords: Indigenous, Native, Engineering, STEM, Indigenous Engineering Students, Indigenous Storywork, Indigenous Methodologies, Undergraduate Native Student Experiences

Chapter Sagwu (One): Introduction to the Study

My Story

Osiyo! My name is Tiffany Diane Smith, and I am Cherokee and an enrolled citizen of Cherokee Nation of Oklahoma, as well as a descendent Muscogee (Creek). I am the daughter of Charles and Diane Nelson and was raised in Midwest City, Oklahoma in a low-income suburban, predominantly white community. Midwest City is home to Tinker Air Force Base – and known throughout the state as one of the more diverse areas in Oklahoma. In 2014, Midwest City was named the fourth most dangerous suburb in the country, according to crime data from 120 suburbs across America that was taken from the FBI's Crime Report (Querry & Hill, 2014). While gangs did exist in my neighborhood, I do not recall ever feeling unsafe. Furthermore, though my schools were still predominantly white, I was fortunate to interact and develop strong relationships with many peers of color.

I am an Indigenous woman who was not raised within my tribal community nor was I raised being familiar with our language, traditional teachings, or ceremonies. My father, Charles, was a white plumber and horticulturist who had grown up in south side Oklahoma City for his entire life, serving in the Air Force Reserve for 2 years and National Guard for 6 years. My dad's family was from Arkansas and eventually matriculated to Norman, Oklahoma. My mother, who is Cherokee, Muscogee (Creek), and white, worked in banking prior to my birth, and then chose to stay home to raise me, and my brother, Ryan, who arrived two years later. My mom's family was from Tahlequah, Oklahoma, though she was born in Geneva, New York, because her father served 22 years in the Air Force. I always remember my mother working part-time as a secretary, substitute teacher, and then reading specialist in our local elementary schools growing up. I am a first-generation college student since neither one of my parents received a college degree. I

always looked up to my parents as role models, as they moved through their careers through much hard work, persistence, and acquired skills, despite not having formal higher education degrees.

Even though my parents did not acquire college degrees, they always pushed education as a central role in future success for my brother and me. My parents always wanted us to achieve more than they did, and higher education was an expectation. I did have some aunts, uncles and cousins complete college degrees, so I felt it was feasible. It was not until just before high school that I think I really understood my Cherokee heritage. Because my Cherokee grandfather, George, on my maternal side, had passed away from lung cancer before I was born, I never had a chance to learn from him. My mother always told me we had Cherokee cousins in Tahlequah, Oklahoma (home to Cherokee Nation of Oklahoma), but we never visited them. She also told my brother and me about my great, great-grandmother, Sarah Still, who was full-blood Native – Cherokee and Muscogee (Creek). The story my grandfather told my mother was that when Sarah had to sign the rolls, she only put down that she was 50 percent Cherokee ancestry because the white settlers would have taken her land. This is a story of settler colonialism[1] far too familiar to many Natives disconnected from their tribal communities.

When applying to colleges my senior year, I applied for Cherokee Nation scholarship support and was fortunate to receive support to attend college at an institution in my home state. Though I had hopes of moving out of state, financial support was an instrumental factor in my decision as we could not afford the out-of-state tuition. An instrumental person through the

[1] Settler colonialism is when "the colonizer's end goal is to eliminate Indigenous people but not before making use of their labor to extract resources for individual benefit" (Minthorn & Nelson, 2018, p. 75). Furthermore, Wolfe (2006) asserts that settler colonialism is when "colonizers come to stay; invasion is a structure not an event" (p. 388).

recruitment process was a Native staff member who worked in Recruitment at this Midwestern institution. He worked with my family closely to get me into college there, and he was my first connection with any faculty or staff. Feeling a sense of belonging through being close to home and knowing him, made my decision much easier.

Consequently, I chose to attend this four-year public institution in Oklahoma. I had immediately started out as an international business major, but then quickly realized I did not want to take that much business calculus. Consequently, after some time with my advisor, I decided to switch to Public Relations by the end of my freshman year. As for my co-curricular activities, I had never had a chance to further explore my Indigenous identity in my K-12 education and was excited to begin connecting with the Native community on campus through organizational involvement, as well as through my nation. Through my close relationship with the American Indian Student Life director, he plugged me in to opportunities with our American Indian Student Association (AISA) and Retaining American Indians Now (RAIN) mentoring organization. Additionally, I was a part of a diversity scholarship class that required a one-hour class enrollment and several other co-curricular commitments to maintain good standing for the scholarship. Furthermore, I applied to be a part of the diversity recruitment program, serving as a tour guide and student recruitment specialist for communities of color. Through these groups, I was able to connect with many Native students, and other students of color, quickly building my community away from home, and further developing my Indigenous identity. My collegiate experience ultimately shaped my newfound cultural identity and current career path in student affairs.

However, identity is complicated. Particularly in being a “white-passing” Indigenous person who has the privilege of checking a box in being biracial. I remember thinking about that

more often in my undergraduate years, as I sought to find my sense of belonging within Native organizations and the Native community on campus. Not everyone was as accepting of me right away with my light skin, but I pushed to do the work in engaging with my community and nation, unlearning colonialist notions and seeking to decolonize my epistemology. Sociologist Herbert Gans (1979) coined the term "symbolic ethnicity," which allows people to claim an ethnicity without changing any behaviors or having real social costs. Due to my whiteness in how I pass through life, I know I have not had to have the same experiences and struggle as many Native people who do not have this privilege. However, I believe that part of claiming an identity is being claimed in return. As an enrolled and active citizen of Cherokee Nation, and in my kinship and connection with not only my own tribal people, but with many Indigenous people across other sovereign nations, I have community and kinship on my side. A recent example contrary to this is Elizabeth Warren's claiming of Indigenous heritage when it was convenient with no kinship or connection to her claimed tribal nation (Sturm, 2009). Consequently, the point is that "white passing" is complicated and contested and bears no fixed meaning.

My connection to engineering came during my new professional years. However, my brother had attended the same institution just two years behind me, and he studied computer science. I remember not understanding engineering and computer science career paths, as it was not discussed during my K-12 years. I never saw it as a pathway for myself, though I excelled in math and science, taking AP classes in high school. I always thought of my brother as brilliant, as math and science came easy to him. He excelled on standardized tests, while I scored average. I knew my success came from hard work and late nights studying. Additionally, my best friend and freshman roommate, who I had attended high school with taking honors classes together,

began studying computer engineering. For some reason, though I was valedictorian of my high school class, I still did not think I could make it in a field like engineering.

Though I went on to get my Public Relations degree, I would later begin working within the engineering department as the director of Student Life for just over 11 years, and eventually becoming the founding director of the Women in Engineering Program. The students accepted me as an "honorary engineer" since I advocated on their behalf, and as a consequence, I become enthralled in engineering education. In the earlier years at the College of Engineering, I worked closely with our Multicultural Engineering Program (MEP) – now known as the Diversity and Inclusion Program – creating and developing a high school girls' camp for students from marginalized identity groups. Additionally, I worked closely with the MEP director in allocating scholarships to students of color, and advising the students along their collegiate journey. As a first-generation, Native college student, I developed close relationships with several students of color within the program. My office became a revolving door for student stories, confidentiality, and most importantly, trust. These relationships evolved into a passion to provide resources for minoritized student success along their journey to an engineering degree.

A couple of years into working in the engineering department, some of my Native students asked me to serve as advisor to our American Indian Science and Engineering Society (AISES) chapter, and I continued in this role for eight consecutive years. Based on my shared cultural identity and with the Indigenous engineering students confiding in me over the years, I developed a passion for determining how we can create a more inclusive community to recruit and ultimately graduate an increased number of Native students in engineering. Furthermore, I was part of the founding committee for the annual American Indian STEM Day program in 2014, which was a one-day outreach program for Native high school juniors and seniors to visit

the campus and partake in interactive STEM activities all the while connecting with Native American engineering and science students, faculty, and staff.

With all of my experiences both personally and professionally, I know I want to give back to my community and work to further advocate for our Native people. It is not only my responsibility, but it is built inherently into who I am as an Indigenous person. My experiences also led me to questioning why I had not pursued an engineering degree when I excelled in both math and science. Why had none of my teachers or counselors ever mentioned engineering as a career option? Engineering education can provide the problem-solving skills to make an impact on our society, and furthermore, for our tribal communities. Just like Wilson (2008) states, I do not see myself, as the researcher, being separate from the research like is more common in the Westernized academy. Rather, I am connected to the participants and all aspects of the knowledge produced from *our* research and have a vested interest in the authenticity and integrity of my work for the betterment of my people and our tribal communities.

Statement of the Problem

Underrepresentation of American Indian[2] students in higher education has been a longstanding problem (Musu-Gillette, Robinson, McFarland, KewalRamani, Zhang, & Wilkinson-Flicker, 2016; Shotton, Lowe, & Waterman, 2013). In 2009, Native students comprised only 1% of the total undergraduate population at postsecondary institutions (Aud, et al., 2011; Snyder, Tan, & Hoffman, 2004). Our lack of matriculation to and persistence in engineering programs is even more dismal (American Council on Education, 2000; Aud et al.,

[2] I use the terms *American Indian, Native American, Native,* and *Indigenous* interchangeably throughout this paper. Shotton et al. (2013) define these terms as "Indigenous populations of North America, particularly those located in what we now know as the United States and those who identify as Native American or Alaska Native" (p. 4). The terms are all descriptive of those who are members or descendants of federally and state-recognized tribes. Natives are recognized as both a racialized minority group and political group due to our membership within sovereign tribal nations (Brayboy, 2006).

2011; NSF, 2017; Smith, Metz, Cech, Hunatoon, & Moyer, 2014). Consequently, the purpose of this study is to understand the lived experiences of Indigenous students persisting in undergraduate engineering programs at non-Native colleges and universities. The research is scarce in sharing Native student experiences who are persisting successfully in undergraduate engineering programs. There is a robust literature on students of color in STEM, but most of it centered on their not persisting in STEM programs (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Espinosa, 2011; Mayes, 2014; Palmer, Maramba, & Dancy II, 2011; Robinson Kurpius, Payakkakom, Rayke, Chee, & Arredondo, 2008; Smith et al., 2014; Strayhorn, 2010; Varma, 2009). Moreso, there is little research on Native students in STEM (Chow-Garcia, 2016).

The lack of research with Native students in engineering in general, as well with issues of representation of Natives in larger quantitative studies is problematic (Byars-Winston et al., 2010; Robinson Kurpius et al., 2008; Palmer et al., 2011; Strayhorn, 2010). Often times, Native students are not even included in studies on students of color in STEM. This exclusion of Native students from institutional data and reporting, the curriculum, research and literature, and the continuous label of statistically insignificant has led to the coining of the term "American Indian research asterisk" (Lowe, 2005; Shotton, Lowe & Waterman, 2013). Furthermore, the lumping together of Native American peoples with other marginalized groups "denies the central and critical difference of American Indians as tribal peoples of distinct nations with sovereign status and treaty rights" (Grande, 2000, p. 344). This inequality leads to feelings of further isolation, marginalization and invisibility of Indigenous students in our society and on our college campuses. As the American Indian College Fund (2019) stated in a recently released report on Native students, "invisibility is in essence the modern form of racism used against Native Americans" (p. 2). Invisibility leads to a disconnect in college access and completion for Native

American students, leading to feelings of alienation that can derail their goals and cause them to drop out (AICF, 2019). Furthermore, Fryberg and Townsend (2008) assert that invisibility is an intentional "writing out" of the story of a particular group, serving to maintain a status quo to benefit the dominant group (p. 175).

Even beyond our higher education institutions is the national call for an increased focus on science and engineering across our country, so that we may remain competitive with other thriving nations (President's Council of Advisors on Science and Technology, 2010). Many have argued that science and engineering capabilities are vital to our success as a nation in the future and to remain competitive in the global economy (Byars-Winston et al., 2010; Espinosa, 2011; Palmer et al., 2011; Smith et al., 2014; Strayhorn, 2010). Knowing this need for the vitality of our nation, we must seek to assess where there are imbalances and misrepresentation of diverse points of view. Native Americans are scarcely represented in STEM programs at the collegiate level, and that is reflected in the workforce. As Native Americans make up 1.9% of the total U.S. population, their numbers in science and engineering are strikingly low (U.S. Census Bureau, 2018). Native Americans earned the least amount of all science and engineering bachelor's degrees awarded with 0.5 percent and are represented even more disparingly in engineering bachelor's degrees awarded with a mere 0.3 percent (NSF, 2017a). Hearing these success stories of Native engineering students could be instrumental in providing role models for younger generations of Native students to pursue engineering pathways, as well as guiding administrators on policy and environmental change necessary at the post-secondary level. It is important to counter these colonizing realities that lead to invisibility, marginalization, and attrition of our Native students in these fields, with research that illuminates the successful experiences of Indigenous men and women sharing their insight for the survival of our tribal

nations and the United States. As higher education administrators, we have a responsibility to ensure that everyone is provided an equitable opportunity for access to our institutions and provided support and resources for success that is relevant to their respective communities.

Additionally, when we turn to perceptions of engineering and science in Indigenous communities, the subjects do not have a positive legacy. The history of exploitation of Native peoples and lands by advancements in science and engineering has created much distrust of American institutions among Indigenous communities (Cajete, 1999). Mainstream institutions have a unique opportunity to educate themselves on how colonization still affects our Native students and their experiences, and how to promote Native students' persistence and participation in science and engineering careers. Indigenous scholar Smith (2012) sums up this trivial history well by stating that "the word itself 'research,' is probably one of the dirtiest words in the indigenous world's vocabulary" due to it being "inextricably linked to European imperialism and colonialism" (p. 1). Consequently, higher education institutions need to understand how colonization perpetuates itself through institutional walls and look at their own practices within their engineering curriculum, research and spaces that may be detracting Native students from attending and persisting in engineering programs. The institutions themselves are responsible for finding ways to create more inclusive curriculum and spaces for our Native students.

Museus et al. (2011) recap the vital need for this scholarship:

> In sum, increasing success among racial and ethnic minority students in STEM is urgent for several reasons, including the fact that it is necessary for the economic well-being of individuals and the nation, America's competitiveness in the international marketplace, the moral and ethical obligation of educators to fight systemic inequities, and the need to

adequately prepare STEM college graduates for the increasingly diverse and global STEM workforce. (pp. 4-5)

Purpose of Study

The purpose of my study is to understand the lived experiences of Indigenous students persisting in undergraduate engineering programs at non-Native colleges and universities (NNCUs).[3] While many researchers (Byars-Winston et al., 2010; Cole & Espinosa, 2008; Griffith, 2010; Leslie, McClure, & Oaxaca, 1998; Simpson, 2000) have used quantitative methods to examine success factors of students of color in STEM majors, this study employs a qualitative, Indigenous methodological approach and focuses on engineering, specifically. This study may inform administrators of NNCUs on successful strategies on how to attract Indigenous students to their engineering programs, provide supportive environments for them, and ultimately graduate them, to contribute to the engineering workforce and the increased vitality of their respective tribal communities.

Research Questions

Through the lenses of Tribal Critical Race Theory and Indigenous Research Paradigm, the research questions were developed with a focus on understanding student experiences in first coming into contact with engineering as a viable career path, and then through their survival in these Westernized programs at mainstream institutions. The central research question in this study is what are the lived experiences of Indigenous students persisting in engineering

[3] I choose to use the term "non-Native colleges and universities" to describe institutions that are predominantly white, and it is a conscious effort to center my research around us as Native people (Shotton, Lowe & Waterman, 2013).

undergraduate programs at four-year, public non-Native colleges and universities? This study will additionally seek to address the following sub-questions:

1. What were the students' pre-collegiate pathways to pursuing an engineering degree?
2. What is motivating and supporting Indigenous students to persist in engineering majors at four-year, public non-Native institutions?
3. How can these lived experiences guide how we as student affairs professionals can better create a supportive community for our Indigenous students in engineering programs?
4. How can we work to promote engineering careers for the betterment of tribal communities and sovereignty?

This broad question allows flexibility for the study to go where the student stories take us in understanding their unique experiences. Additionally, the sub-questions allow for further elaboration on pre-collegiate experiences that led to their attending their institutions and studying their particular engineering majors, as well as storytelling about internal and external motivators for their persistence in their programs. The last two questions look at implications for both higher education institutions and tribal communities in better ways to attract and support Native students through engineering programs, and in creating ways to integrate relevance to tribal communities.

Significance of Study

This study is significant in multiple ways. First, it was conducted and analyzed through an Indigenous lens and moves beyond deficit studies to more culturally affirming stories of Indigenous students in the field of engineering. Through the privileging of an Indigenous framework and utilizing Indigenous methodologies, this study is significant in its ability to affect change at the structural (for policy makers), institutional (for administrators), community (tribal

leaders), and individual levels. Additionally, this study contributes to the significant gap in the literature on Native American student experiences in engineering (and STEM in general), and has the ability to be mutually beneficial to enriching tribal communities, contributing to further equity and access to higher education, as well as to the overall well-being of our country (Lee, Donlon, & Brown, 2010). Consequently, I will delve further into the significance of this study through three major societal issues: 1) an increasingly more diverse nation (Colby & Ortman, 2015; Conrad & Gasman, 2015); 2) the high attrition rates of students in STEM (Chen & Soldner, 2013), particularly for students of color (Chen & Soldner, 2013; Chubin & Babco, 2003; Palmer et al., 2011), and 3) the disconnection of engineering messages with the general public (National Academy of Engineering, 2008).

Diverse Nation

Recent projections have indicated that by 2050, nearly half of the U.S. population will be non-white (Colby & Ortman, 2015; U.S. Census Bureau, 2002). The "two or more races" population is projected to be the fastest growing, comprising 6.2 percent by 2060 (Colby & Ortman, 2015). With this massive increase in diverse individuals, the U.S. will have to draw talent from historically underrepresented groups to maintain, and furthermore increase, it's technological capabilities (NAE, 2004). Additionally, engineering solutions will only continue to serve our nation if these solutions are provided through the lens that is reflective of our diverse consumers. Given that higher education is a major producer of graduates to support the STEM workforce, higher education officials can no longer ignore this growing group of students of color.

The diversity imperative, particularly in STEM, is of great concern to our nation. Failing to engage students of color will inevitably lead to shortfalls in our STEM workforce, and more

importantly, “will prevent the STEM professions from capitalizing on the power of human diversity, a historical strength and competitive edge of the American economy, and will deprive some of our citizens from the engaging in rewarding and remunerative careers” (Handelsman & Smith, 2016, p. 2). Additionally, a recent policy report from the President’s Council of Advisors on Science and Technology (PCAST, 2012) called for colleges and universities to produce more STEM graduates to meet the needs of the workforce. The report projected that the U.S. would need one million more STEM professionals over the next decade than it was estimated to produce, in order to maintain its global prominence and prowess in science and technology (PCAST, 2012). Consequently, the U.S has invested hundreds of millions of dollars into advancement of diversity in STEM through the launching of federal campaigns. Furthermore, I will discuss many of these federal STEM campaigns, as well as sharing the few limited initiatives aimed at supporting Native American students in STEM, specifically.

Federal initiatives. From early in President Obama’s administration, he emphasized the importance of strengthening the nation’s STEM workforce as a key priority. In doing so, his administration’s efforts over the last seven years have led to unprecedented public-private collaborative efforts in STEM education (Handelsman & Smith, 2016). His administration was able to secure more than $1 billion in private investments for the sole purpose of improving STEM education across the U.S. as a part of President Obama’s *Educate to Innovate* initiative (Handelsman & Smith, 2016). In 2009, this initiative was launched in an effort to regain the U.S.’s dominance in science and mathematics achievement through a series of collaborative efforts of the federal government with companies, foundations, non-profits, and science and engineering societies (“Educate to Innovate,” 2013). One of the major goals of the initiative was to broaden participation to inspire a more diverse STEM pool, focusing on students of color and

women ("Educate to Innovate," 2013). As a part of this particular goal, initiatives such as NASA/Girl Scouts of the USA partnership sparked, as well as the Department of Energy's Women in STEM mentoring program and numerous other programs ("Educate to Innovate," 2013). Furthermore, the White House issued a call for tech inclusion in 2013, which was intended to encourage leaders from public and private sectors to come together to ensure that youth from marginalized communities, including women and girls, have the opportunity to study STEM subjects in an effort to provide them with more opportunities for pathways to technology careers ("Educate to Innovate," 2013).

Many other initiatives spurred as a result of President Obama's *Educate to Innovate* campaign and national push for public and private sectors to collaborate. The Obama adminstration was able to invest $3 billion across 14 federal agencies for STEM education programs (Handelsman & Smith, 2016). Included in these efforts is the annual White House Science Fair, more than 350 commitments from colleges and universities to provide pathways for students of color to STEM degrees, and the Department of Education prioritizing STEM education with such initiatives as *Race to the Top*, the largest-ever federal competitive investment in school reform (Handelsman & Smith, 2016). Moreover, in President Obama's 2017 budget, the National Science Foundation (NSF), as part of its Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES) program, invested $16 million in alliances to develop new ways to increase diversity in STEM (Handelsman & Smith, 2016).

With these opportunities being set forth, the 2017 budget prioritized three major areas in the *STEM for All* effort to support STEM education for all students: 1) refining STEM classroom experiences, 2) expanding access to rigorous STEM coursework, and 3) addressing bias and

expanding opportunities for students of color in STEM (Handelsman & Smith, 2013; White House, 2016). Recent data from the Department of Education's Office for Civil Rights revealed that 50 percent of U.S. high schools do not offer calculus and 27 percent do not offer physics, which are key courses in preparing students for success in engineering and many other STEM fields (White House, 2016). As a result of these startling statistics, the White House administration addressed the STEM course gap through other initiatives such as *Computer Science for All*, which proposed $4 billion at the Department of Education for states to increase access to hands-on computer science P-12 classrooms and $100 million in competitive grants for districts who expand computer science efforts for all students, with a particular focus on those from underserved communities (White House, 2016). At the higher education level, a major effort was investing $108 million in Hispanic-Serving Institutions (HSIs) STEM and articulation program, and sustaining such early readiness programs as Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) and federal TRIO programs (White House, 2016).

While these efforts are necessary and have had much success in certain areas, once again we see that women and all students of color are being lumped together, when distinct initiatives are needed to improve access and participation of each racial/ethnic group. Additionally, there were no initiatives aimed at increasing participation of Native students in STEM, when we are the most underrepresented group in these fields. Targeting tribal colleges and universities (TCUs) could have been another avenue to affecting change for Native students in STEM that could further be emulated by large public institutions. Furthermore, STEM is once again lumped together with no mention of distinguishing the complexities of science and engineering careers.

Native American initiatives. Despite all of these massive federal-led efforts, little to no gains have been made in increasing Native American participation in STEM fields, as is indicated by our dismal numbers in these fields to this day. Recent data demonstrates that while American Indian and Alaska Natives make up 1.2 percent of the total U.S. population, they represent only 0.4 percent of all engineering bachelor's degree recipients and only 0.3 percent of the engineering workforce (National Conference on State Legislators, 2016). Even with this strikingly low representation, it was surprisingly difficult to unearth any efforts that addressed Native American students' access to and persistence in STEM. After much research beyond federal documents, a couple of organizational efforts surfaced who have recently supported the dire need for these efforts.

The Department of Energy hosted a two-day National Tribal Energy Summit in 2015 with tribal leaders as a result of the Obama administration's push to strengthen the government's relationship with tribal nations (National Conference on State Legislators, 2016). The Secretary of Energy Ernest Moniz learned about the need for STEM-educated tribal members due to the large amounts of land and natural resources tribes need to steward for economic development. The summit led to the Secretary's commitment to a series of roundtables on the status of STEM in Indian Country (National Conference on State Legislators, 2016). The result was the National Indian Country STEM Effort and Workforce Development Initiative, which involved several tribal leaders in both public and private sectors with the task of developing a grander STEM strategic plan across Indian Country. Much of the discussion covered resources and target areas in K-12 education in forging ahead. Unfortunately, no further recent documentation could be found regarding further efforts since this initial meeting.

In regards to higher education initiatives specifically aimed at increasing representation of Natives in STEM, the American Indian Science and Engineering Society (AISES) has been a leading national organization addressing these efforts since its establishment 40 years ago. In 2014, AISES was awarded a $1.5 million grant from NSF, the largest NSF grant AISES has ever received both in amount and scope, to support their program, "Lighting the Pathway to Faculty Careers for Natives in STEM" (AISES, 2014). The program was implemented to boost the number of AISES students persisting in STEM, with a long-term goal of increasing the number of Native faculty members. Intended to be a five-year pilot project implemented at the national level, student participants are provided with a plethora of mentoring and support opportunities to encourage their pathway to faculty at all types of institutions, to include tribal colleges (AISES, 2014).

As President Obama and his administration made clear, it is everyone's responsibility to ensure we are prepared to maintain our needs for a dominant STEM workforce, as well as responding to the ubiquitous diversity imperative. We must tap into our nation's most promising assets of human diversity, and seek to empower our tribal nations for America's sake. While some nationwide efforts are underway to encourage broader and greater participation in STEM, our Native representation in STEM, and particularly engineering, remains dismal, thus, making the need for uncovering experiences of Indigenous students even more imperative to understanding how we can better serve their needs. This study has the ability to offer insight into highlighting what is peaking Native students' interest in pursuing engineering pathways, and furthermore what we can do to nurture their persistence and graduation in these fields.

STEM Attrition

With all of the aforementioned initiatives to support broader participation in STEM, attrition rates of students of color continue to be problematic in these fields (Chen & Soldner, 2013). While my study seeks to highlight the stories of persistence, it is important to acknowledge those students who are not persisting for various reasons in seeking to understand why STEM attrition is so astronomical, and particularly so for students of color. The problem is even more acute when we look at Native American students, and although precise retention data is difficult to obtain for a number of reasons, estimates of higher education attrition rates for Indigenous students range from 75 to 93 percent (Brown & Robinson Kurpius, 1997; Benjamin, Chamber, & Reiterman, 1993; Larimore & McClellan, 2005).

With the significantly high rates of attrition of Native students in post-secondary education in mind, we then turn to general STEM attrition.[4] In regards to STEM talent, the U.S. trails several key competitors when it comes to those completing a STEM undergraduate degree, and has one of the lowest ratios of STEM to non-STEM bachelor's degrees in the world (National Science Board, 2012). With the emphasis on increasing STEM graduates for the vitality of our nation, this ratio presents the stark reality of the low quantity of STEM graduates the U.S. has in relation to other countries, which could also provide an argument for increasing efforts to understand and include our most underrepresented group – Indigenous students. Furthermore, more than half of the freshmen in STEM majors left these fields before graduation (Chen, 2009; Chen & Soldner, 2013; Higher Education Research Institute, 2010). Studies have frequently found that women, students of color, first-generation students, and those from low-

[4] I use the term *STEM attrition* to refer to "enrollment choices that result in potential STEM graduates (i.e. those who declare a STEM major) leaving STEM fields" (Chen & Soldner, 2013).

income backgrounds leave STEM field at higher rates than their counterparts (Anderson & Kim, 2006; Hill, Corbett, & Rose, 2010; Griffith, 2010; Huang, Taddese, & Walter, 2000; Kokkelenberg & Sinha, 2010; Shaw & Barbuti, 2010). There is even evidence linking STEM attrition to such psychological factors as motivation, self-efficacy, and confidence in one's capacity to learn STEM material (Chang, Cerna, Han, & Sàenz, 2008; Gloria & Kurpius, 2001; Hurtado et al., 2008; Leslie, McClure, & Oaxaca, 1998).

In a recent study of STEM leavers, Chen & Soldner (2013) found that the type of first institution was significant in the students' decision to leave the major, and that those who attended four-year public institutions had a higher probability of switching from a STEM major than those who attended private institutions. Additionally, their study indicated that those who took lower-level math courses the first-year were more likely to switch out of STEM majors, indicating that academic preparation before entering a STEM major in college plays a major role in student persistence in that field (Chen & Soldner, 2013). Those students who took less STEM credits in their first year, as well as their performance in these courses were other major factors associated with students leaving STEM majors in this study.

With the high attrition rates of Native students in general coupled with the high attrition rates in STEM fields at the post-secondary level, it further complicates recruiting and graduating Native students in engineering fields. Furthermore, across all measures, Native students fare far worse in educational outcomes, to include having the lowest high school graduation rate of any racial/ethnic group across all schools and the lowest percentage of bachelor's degree completion (U.S. Executive Office of the President, 2014). Additionally, living conditions affect Native children from gaining access to higher education with many living in poverty and in remote locations with less access to technology (Conrad & Gasman, 2015; DeVoe & Darling-Churchill,

2008; U.S. Executive Office of the President, 2014; Varma, 2009; Williams & Pewewardy, 2009). All of these realities make it difficult to gain access to STEM opportunities and preparatory coursework prior to college.

In 2014, President Obama released a report on the state of Native youth in our country that stated that "Native youth and Native education are in a state of emergency" (U.S. Executive Office of the President, 2014, p. 19). This report was a result of a visit by President and First Lady Obama with six Lakota youth from the Rosebud Reservation in South Dakota, in which the youth shared the stark realities of their lives. The Obama administration's efforts sparked a vital discussion for both the U.S. and Indian Country. We are doing our nation a disservice to not be ensuring our youth are gaining access to a quality education across all communities. Students who attend high-poverty schools – like many from Native communities – frequently have less resources to access experienced teachers in the core areas of science and mathematics (U.S. Department of Education, 2016). My study advocates that engineering education could be an opportunity to creating better lives for our youth and the enrichment of our tribal communities and resources. However, there are still challenges ahead in the way messages are communicated about engineering, specifically, in contrast to other science, mathematics, and technology fields. This is particularly important when conveying engineering pathways as relevant to Indigenous communities.

Engineering Messaging

In order to contribute to the increase of participation of Native American students in engineering, culturally relevant messaging about engineering professions is necessary. The messaging that women and students of color hear early on in regards to engineering could affect our future leadership and success in the U.S. Consequently, the National Academy of

Engineering (NAE) (2008) published a report on "Changing the Conversation: Messages for Improving Public Understanding of Engineering," to gather data on how the general public views the profession of engineering, and effective messages to our youth. NAE (2008) emphasized three main reasons for improving public understanding of engineering: 1) sustaining the U.S. capacity for technological innovation; 2) attracting young people to careers in engineering; and 3) improving technological literacy. They argue that a better understanding of what engineers do would educate policy makers, our youth, and the general public about the technological and economical contributions of engineers, in addition to the increase in quality of life (NAE, 2008).

The NAE (2008) conducted several focus groups on their perception of engineering, and found that technical aspects are often emphasized versus the creative opportunities to impact our nation, which can lead to discouraging messages for many. This messaging can be particularly harmful for those from marginalized and economically disadvantaged backgrounds, who have not had access to quality resources in K-12 education preparing them for the level of mathematics and science necessary to equip them for success at the post-secondary level. Though the researchers found that overall perceptions of engineering were positive, they also discovered that both students and parents interviewed had a limited sense of what engineers do (NAE, 2008). There was an overall emphasis on the mathematics and science skills needed to obtain an engineering degree, rather than the "vital characteristics of engineering, such as creativity, teamwork, and communication" (NAE, 2008, p. 10). This general misunderstanding aligns with other previous research that found that K-12 teachers and students also have a poor understanding of what engineers do (Cunningham & Knight, 2004; Cunningham et al. 2005, 2006). Consequently, the data from the NAE report (2008) suggests that "public perceptions of engineering are based on a limited idea of what it takes to *do* engineering (e.g., skill in

mathematics and science), rather than what it means to *be* an engineer (e.g., to work creatively in teams to develop technologies that improve people's lives)" (p. 23). This can be better understood through thinking of how the medical profession is perceived as one that can make a difference and save lives. Engineers have the ability to develop solutions to major challenges we face as a nation, and can also make an impact and save lives. A career in medicine requires a lot of mathematics and science coursework, but why then is the messaging so different for a doctor versus an engineer?

Assessing engineering messages and perceptions are important to understanding what we can do to make changes to encourage broader participation in these careers. Particularly for Native American students, the connection to giving back to their respective tribal communities and improving quality of life is important. Much of the dissonance between Indigenous communities and STEM is not having a clear understanding of how these professions are beneficial to society and tribal communities (Miller, 2010; Tsui, 2007). The *STEM 2026* report states a clear vision for the state of U.S. STEM education, and one of their major components was a focus on more societal and cultural images and environments that promote diversity in STEM opportunities and careers (U.S. Department of Education, 2016). As a part of this vision, a key piece to achieving more diversity in STEM mentioned was repeated exposure to STEM-themed media, that can be common in reversing implicit biases in STEM, as well as deepening the understanding and relevancy of STEM in all people's lives and communities (Traphagen & Traill, 2014; Volmert, Baran, Kendall-Taylor, & O'Neil, 2013; U.S. Department of Education, 2016). The federal government sees the need to make engineering more culturally relevant, as well the importance of promoting images of engineers that reflect the diversity of our nation. Thus, these same efforts should be mirrored at our U.S. institutions of higher education.

Summary of Significance

The diversity imperative fueled by our nation's shifting demographics, the high attrition rates of students in STEM and Native Americans in higher education, as well as the importance of more culturally relevant engineering messages necessitates research on exploring the lived experiences of Native Americans who are persisting in engineering undergraduate programs at four-year, public, non-Native institutions. Just as President Obama experienced by his visit to the Rosebud Reservation in South Dakota that sparked the White House's report on the state of Native youth and education, this study has the ability to affect policy change by providing insight into the lived experiences of Native students in engineering programs. This study can contribute to the gap in the literature in a culturally responsive manner to help administrators, family members, youth, and tribal leaders have a better understanding of what influences Indigenous students' matriculation to non-Native institutions to study engineering, and what is motivating them to persist in these majors where there are so few other Natives. Accordingly, this study could provide insight that is integral to the well-being and sovereignty of Indigenous peoples and our resources. Shilling (2015) supports these efforts by stating that:

> Every child is imbued with a sense of curiosity and wonder. They are born scientists, engineers, and creators ready to discover the world at every turn. The goal of education should be to sustain engagement throughout a lifetime. (para. 1)

Like Shilling expresses, *every* child should be our concern, and for higher education, every *student* should be our concern. When there are disparities, we need to seek out understanding and solutions.

Outline of Dissertation

This dissertation will be organized into five chapters and an appendices section. Chapter one established a general overview and introduction to the researcher and study, statement of the problem, the research questions to be addressed, and the purpose and significance of study. Chapter two will present a comprehensive review of the current literature. Chapter three will provide an overview of my research design, to include my methodological approach, theoretical framework, rationale for my approach, researcher positionality, data collection methods, and my step-by-step plan for analysis of the data. Chapter four will introduce the seven engineering students and their pathways from childhood up to their collegiate experiences in engineering programs. Chapter five will present our co-constructed findings through the sharing of participant stories organized into themes. Furthermore, chapter six will provide an analytical discussion of the findings as it relates to the current literature and theory and considers the implications for academic and tribal settings. An appendices section will follow that includes copies of the internal review board's approval of the research study, informed consent form, recruitment e-mail, conversation protocol, and the reflective journal protocol utilized.

Chapter Tali (Two): Review of Literature

Introduction

Until more recently, Indigenous students' experiences have been virtually ignored and silenced in regards to higher education. Invisibility is in essence the modern form of racism used against Native Americans (American Indian College Fund, 2019). Furthermore, invisibility is a form of settler colonialism, where erasure is the aim (Tuck & Yang, 2012; Wolfe, 2006). Research exploring and sharing valuable stories of Indigenous students in STEM fields, and particularly in engineering, is almost non-existent. Understanding Native student experiences will assist in informing administrators of how to build more trusting and mutually beneficial relationships with tribal communities. Additionally, highlighting the experiences of Native students persisting in engineering majors will shed light on how administrators can provide a more nurturing environment for their success and contributions to this field. Furthermore, their success provides young generations of Native students with role models and a clearer understanding of the direct connection of an engineering degree to the revitalization of their own tribal communities.

In the current literature, students of color are often lumped together, Indigenous students often being dismissed or denoted by an asterisk, or STEM majors are noted as having the same experiences across all of the various disciplines. Furthermore, it is important to note that there is not one singular Native experience in higher education (Shotton et al., 2013), as the Native population is extremely diverse with 574 federally recognized tribal nations and many state-recognized tribes[5] (National Conference on State Legislators, 2018). The complex racial and

[5] According to the National Conference on State Legislators' latest tally, there are 63 state-recognized tribes. State-recognized tribes are not federally recognized and thus do not receive federal funding support, though some federally recognized tribes may also be state-recognized (NCSL, 2018).

political (tribal) identities Native students carry with them create unique experiences when they come in contact with higher education institutions. Consequently, there is a dire need for more research centered on Native student experiences in higher education in general, and even more so in technical fields such as engineering, where Native students are the most underrepresented group with less than one percent of bachelor's degrees awarded (NSF, 2017). Furthermore, American Indian/Alaska Native students were the only racial and ethnic group to experience a decrease in the number of bachelor's degrees awarded in engineering from 2011 to 2016 (Anderson, Williams, Ponjuan, & Frierson, 2018). The decline in engineering bachelor's degrees awarded follows a larger trend among this group, as the number of non-engineering bachelor's degrees for American Indian/Alaska Native students also declined by 19 percent from 2011 to 2016 (Anderson et al., 2018). Enrollment at four-year colleges and universities also saw significant decline at 23.3 percent from 2010-2016 (Anderson et al., 2018). These devastatingly low numbers of Native graduates should not only alarm higher education administrators but should make them pause to ponder why Native students are not matriculating to higher education institutions in general, and particularly in pursuing engineering pathways. Consequently, understanding the context of colonists' contact with Native peoples from a historical perspective will provide greater understanding of the complexities that continue to plague our views of higher education institutions to this day.

Tippeconnic Fox, Lowe, and McClellan (2005) contest that "American Indians are victims of a legacy which includes economic exploitation, military conquest, political manipulation, and social disregard. Education, including higher education, has been a part and parcel of the development of that legacy" (p. 8). Consequently, I will provide a review of literature that starts with the history of U.S. education for Native people, the current state of

Native students in higher education, and what we know about students of color and women in STEM and retention strategies currently in place. I will conclude with a review of the limited literature on Native students in STEM, and a look at the retention theories. This chapter seeks to acknowledge the heart work of researchers and scholars who have come before me and have forged a path to lead to this study. The purpose of this literature review is to understand the historical contexts of U.S. policies and perpetuating ideologies that have shaped the present state of higher education for Native American students, so that we have a starting point to work toward true systemic change for future generations of Native students in the academy.

History of Native American Education

When working with our Indigenous communities, it is important to understand the historical trauma from colonization that still influences how formal Westernized education is viewed by tribal communities in the modern day. The need to look back at our past will allow a better understanding of the tumultuous relationship between Indigenous people and educational institutions in the United States. These mainstream institutions of higher education, or non-Native institutions, were not designed for Indigenous students (Brayboy 2006; Patel, 2016; Waterman, Lowe, & Shotton, 2018). Native students are put at an immediate disadvantage upon setting foot on mainstream campuses that are rooted in colonial systems brought here by western Europeans (Patel, 2016).

Historically, Native American education was viewed as something that needed to be "fixed" by colonists, and thus, schooling was the primary strategy for colonizing Native peoples (Huff, 1997). Patel (2016) stresses that in order to combat coloniality, we must distinguish schooling from learning in this context. Federal boarding schools were established for the sole purpose of schooling, or assimilating Natives to the dominant American culture (Deloria, 1991;

Huff, 1997), as was evident in Pratt's popular slogan of "kill the Indian, to save the man" (Lomawaima & McCarty, 2006; Reyhner & Eder, 2004; McClellan, Tippeconnic Fox, & Lowe, 2005). The colonizers devalued Indigenous knowledge with the explicit goals of erasing Indigenous paradigms, and replacing them with Christian ideologies (Huffman, 2001; Shotton et al., 2013), weaponizing both schooling and organized religion to maintain a status quo and to erase tribal identity. In uncovering the experiences of Kiowa people at Rainy Mountain Boarding School in Oklahoma, Ellis (2008) notes how boarding schools sought to strip Indigenous students' cultural identities through the forced removal of their hair, traditional clothing, language, and their Native names. With the intent to erase Indigenous culture and identity from existence, Adams (1988) points out how the Protestant ideologies forced upon Native people were the Eurocentric hopes for civilizing savage peoples with a primary drive of acquiring Native lands. He describes these assimilation efforts with the following:

> If only Indians would accept [the Americanizing lessons of Christianity, capitalism, and republicanism], they would come to enjoy the blessings of civilized progress. But even then – and this was always clearly understood – they must continue to give up the land. Such was the deep meaning of Indian education. (p. 23)

Consequently, distrust of American educational systems is common among Native American communities (Guillory & Wolverton, 2008; Martin & Thunder, 2013; Smith, 2012; Waterman, 2011). Such distrust could be an indicator of why some Native students choose to not attend mainstream institutions. These institutions were not built for Indigenous students and embody ideologies conflicting with their own cultural beliefs, whether that be through the physical structures on campus to the non-physical structures of organization, curriculum and experiences. In their recently released article *Colonized and Racist Indigenous Campus Tour*,

Minthorn and Nelson (2018) assert that "though many of the building and images [on college campuses] are inaminate from a Western viewpoint, an Indigenous lens demonstrates that each of these items carries energy" that embody the histories of colonialism and genocide that impact Native student experiences (p. 12). Many of these original colonialist structures still exist and are pervasive on mainstream college campuses. The goal was – and continues to be – assimilation to a Westernized belief system even if the costs were detrimental to students' well-being and preservation of culture. This was all a part of a conquest to acquire Indigenous lands by force. We are still reminded daily of these conquests on these mainstream institutions that continue to perpetuate such ideals of colonialism and westernized epistemologies.

Furthermore, to provide perspective into this distrust of westernized educational systems, it is important to pivot to the historical context of Native American higher education. McClellan, Tippeconnic Fox, and Lowe (2005) emphasize the complex and tumultuous history of Native American higher education through three distinct eras: The Colonial Era, Federal Era, and Self-Determination Era. Through the chronological description of these three periods in history, I hope to provide further insight into Native American resistance to colonized education at American institutions.

Colonial Era. The Colonial Era marks the pinnacle point of contact between colonists and Native Americans and extends to the Revolutionary War. The first contact is often pronounced by Columbus' "discovery" of the Americas in 1492. Consequently, nine colonial colleges formed, while only three explicitly stated their mission to educate Native Americans (McClellan et al., 2005). However, these three consisting of Harvard, William and Mary, and Dartmouth, failed to educate Natives, graduating only four of 47 enrolled (McClellan et al., 2005). Their missions appear to be a façade that had no intention of actually progressing

education for Natives. Furthermore, while this era marks a point of forced assimilation for our tribal communities, colonists gained another victory of destroying Indigenous culture and ways of knowing that continues to manifest itself in every facet of modern institutions of higher education today. Lomawaima (1999) affirms the goal of colonial colleges was "to transform Indian people and societies and eradicate Indian self-government, self-determination, and self-education" (p. 5). With colonialists' ideals still being passed down and reflected in our institutions, this can be a major deterrent for Indigenous students not attending mainstream institutions.

Federal Era. Marked by the American Revolution of 1776, the Federal Era led to the development of multiple treaty relationships between tribal nations and the federal government, laying out guidelines for educational access for tribal members. During the late 1800s to early 1900s, college development was at its peak, with institutions created for women and African Americans, but Native American higher education continued to be overlooked (McClellan et al., 2005). Unfortunately, the federal era became notable for its failure to provide educational access for Native Americans and more on a focus of vocational education through the establishment of boarding schools (McClellan et al., 2005). Boarding schools were first established by Captain Richard Henry Pratt, a colonel within the United States' Army, who believed that these schools could create a multiracial society where everyone acted like white Christians (McClellan et al., 2005). Forced removal and assimilation was popularized by Pratt's slogan of "kill the Indian in him, save the man," (Reyhner & Eder, 2004; McClellan et al., 2005). Pratt's slogan would become the official philosophy for all 88 reservation boarding schools, leading to justification for tearing families apart, and prohibiting tribal languages and traditions. The effects can still be felt today as reservations still exist, and there are efforts to revitalize tribal languages that have been

lost. This type of mentality today is known as the White Savior complex,[6] when white Americans validate their power and privilege by seeking to transform marginalized communities. This complex has continued to manifest itself over time, especially as seen through Christian mission trips and Christian symbols on mainstream college campuses. This is another way that colonization pervades communities to this day, and part of the reason there is still much distrust of American educational institutions passed down through generations of Indigenous communities (Guillory & Wolverton, 2008; Martin & Thunder, 2013; Waterman, 2011).

Self-Determination Era. The last major era brings us to the current day, and has certainly brought about the most positive changes to Native American education as it ushered us into a period of tribal control of education (Shotton, Lowe, & Waterman, 2013). The Progressive Movement and the Indian Reorganization Act in 1934 were key moments during this era that led to Native self-determination of education (Carney, 1999; McClellan et al., 2005). Federally designated funds and tribal governments created scholarships to support Native students through their collegiate journeys, and Tribally Controlled Colleges and Universities (TCUs) were established to hand over power to tribal nations to create institutions based on their own cultural foundations (Carney, 1999; McClellan et al., 2005). The establishment of the first tribally controlled community college, Dine College, founded by the Navajo Nation in 1968, led to the creation of now 37 TCUs with more than 75 sites in the United States providing access to higher education to over 80 percent of Indian Country (AIHEC, 2019).

[6] Teju Cole (2012) notes that the White Savior Industrial complex is a perception that white people have that they are the benevolent benefactors of helpless 'others.' It pervades this 'white hero' as invading another country/culture to help those that are marginalized.

Despite the increased financial and institutional support for Native Americans to gain access to higher education, there was modest growth in Native American enrollment from the 1940s through the 1960s (Carney, 1999; McClellan et al., 2005). This leads to the present day where Native American enrollment at higher education institutions has increased overall, but attrition rates continue to be alarmingly high and Natives are still the most underrepresented minoritized group in higher education (Brown & Robinson Kurpius, 1997; Shotton et al., 2013). As discussed, the U.S. government has a long, destructive history of taking Native lands, and in so doing, assimilating Native Americans through formal education. This has undoubtedly led to historical trauma for Indigenous peoples and a continued distrust of westernized systems of education, including higher education (Cajete, 1999).

Only in the last five decades have we seen a shift from the assimilationist goals of Native American higher education to a time of self-determination and a rise of recognition of Indigenous knowledges and cultures. More recently, theories of Native nation building have offered a more relevant narrative for Native students, allowing students to see education as one that will improve the livelihood of Native nations through assertion of Indigenous knowledge systems and tribal sovereignty (Brayboy, Fann, Castagno, & Solyom, 2012). Yet, given the traumatic history of culturally misaligned teachings through the forced Eurocentric educational systems, Native American students continue to face a plethora of cultural, structural, and institutional challenges along their pathways to college access and completion. These encounters are reflected in the current literature on the state of Native students in higher education.

Native Students in Higher Education

From 2000 to 2010, enrollment of students of color has increased for all groups (NCES, 2018). However, during the 2010-2016 timeframe, Black, white, and Native groups declined in

enrollment for their undergraduate education, while Asian/Pacific Islander students remained relatively unchanged (NCES, 2018). American Indian/Alaska Native enrollment decreased more than any other racial/ethnic group by 28 percent. According to the latest data from fall 2016, American Indian/Alaska Native students comprised a mere 0.76% of all undergraduate students, making them the least represented amongst all minoritized students (NCES, 2018; Robinson Kurpius et al., 2008; Shotton et al., 2013). Though higher education enrollments continue to increase for Native students, they still remain less likely than their peers to enroll in college (DeVoe, Darling-Churchill, & Snyder, 2008). Even prior to college, Native students are struggling at the high school level with declining graduation rates, while African American and Latino/a students are continuing to make strides (Sheehy, 2013). The alarmingly low numbers of Native students entering and persisting in college should cause for concern when other groups of color are on the rise. With a predicted majority people of color by 2050 due to immigration and increased minority births (Conrad & Gasman, 2015, p. 14), higher education policy makers and administrators should be concerned with how they can better support Native students, a diverse group of people still struggling to be visible on college campuses.

As far as Native undergraduate enrollment at postsecondary institutions, not much has changed over the years. Lowe (2005) states that "Native Americans continue to be underrepresented both in the more prestigious private and four-year sectors of higher education and over-represented in the less prestigious public and two-year sectors" (p. 34). In 2016, 81 percent of all American Indian/Alaska Native students were enrolled at a public institutions, while 12 percent were enrolled at private non-profit institutions and 7 percent at private for-profit institutions (NCES, 2019). Consequently, majority of Native students continue to be enrolled at public NNCUs. As the American Indian College Fund (2018) stated in their recently released

report on Natives in higher education, “public colleges and universities have a moral imperative to serve all of the people of their states, and that includes the Indigenous peoples of that land and states where college campuses exist” (p. 14).

Although Native students seem to be enrolling predominantly at NNCUs, their retention and graduation rates are the lowest, with attrition rates estimated between 75% and 93% (Brown & Robinson Kurpius, 1997; Shotton, Lowe, & Waterman, 2013). Unfortunately, this is the most recent data accessible on Native student attrition rates and is a limitation in the data. Some scholars have noted the complexity of accurately determining retention data for Native students (Boyer, 1997; Carney, 1999; Tierney, 1992). Recent statistics from the U.S. Census Bureau indicate that 14% of American Indian and Alaska Native people age 25 and older have a college degree compared to 30.3% of the overall population (American Indian College Fund, 2018). Native people seem to be falling behind when it comes to obtaining college degrees, and this can be concerning in the lack of knowledge and skill sets they can be bringing back to their tribal communities. Furthermore, much of the current research on Native American student persistence focus on deficit factors, instead of looking at the positive factors leading to Native student success at mainstream institutions. Many of the deficit factors presented in the current literature focus on financial issues, lack of academic preparedness coming into college, lack of Native role models on campus, family and cultural obligations, and lack of institutional support (Brown & Robinson Kurpius, 1997; Lundberg, 2014; Lundberg & Lowe, 2016; Mendez, Mendoza, & Malcolm, 2011; Shotton et al., 2013; Smith et al., 2014; Waterman, 2007). However, I wanted to rethink the previous dominant narrative, and hear the stories of resilience of our Native students in what is influencing their persistence, not holding them back. While the grim statistics show we have much work to do at our higher education institutions, I want this research to highlight the

support structures that are encouraging Native students to persist in college. Keene (2016) discusses how in the last few years there has been a "growing movement to reframe the conversation around the success, joy, strength, and power in Native communities around education" (p. 76). Consequently, I will give an overview of the barriers to persistence that many scholars have identified for Native students, but then will move into the known persistence factors to lay a foundation for my study's contributions.

Barriers to access. Native American students face unique barriers to access to higher education. Consequently, an extensive number of scholars have investigated the barriers faced by Native Americans. Though this dissertation focuses on how Indigenous students persist in undergraduate engineering programs, stories of struggles overcome will certainly be a part of the conversation. Understanding the barriers that Native students face before even entering the academy will provide context to the systemic struggles they must overcome on their pathway to higher education. Since my study looks at my participants' experiences leading up to their entering college to better understand how we attract Indigenous students to engineering programs, it is important to share the research that shapes the current narrative of Indigenous pre-college experiences. While previous literature identifies a number of issues, most prevalent are financial difficulties, inadequate academic preparation, and cultural conflict (Deyhle, 1992; Falk & Aitken, 1984; Huffman, Sill, & Brokenleg, 1996; Huffman, 1993, 1999, 2001; Jackson et al., 2003; Lin, 1985; Lin, LaCounte, & Eder, 1988; Scott, 1986; Wells, 1997). Furthermore, many Native Americans live in remote, poverty-stricken areas, and lack educational and computer resources, making academic preparation and access to education more challenging (Conrad & Gasman, 2015; Varma, 2009; Williams & Pewewardy, 2009). According to DeVoe and Darling-Churchill (2008), one in every four American Indians are living below the poverty line.

Consequently, financial aid is often a ubiquitous and formidable barrier to higher education for many Native students (Mendez et al., 2011).

With all of these challenges described in the literature, higher education administrators should be concerned with outreach to tribal communities as a way of bridging the access and achievement gap. NNCUs currently enroll the most Native students, yet Native students are still the most underrepresented group on these campuses and are certainly not graduating at high rates. Therefore, NNCUs must make concentrated efforts to outreach to local tribal communities to better understand the needs of Native students in order to even recruit them to their campuses. Then, they must work tirelessly to provide support structures to contribute to Native student persistence and graduation. Smith et al. (2014) emphasize the importance of communal work goals for Native American students, which is defined as value placed on enriching their tribal communities. Cajete (2005) further supports the collectivist perspective of Native American cultures, rather than the more Western view of individualism, which occurs at many American mainstream NNCUs (Burk, 2007). Many scholars (Gentry & Fugate, 2012; Lundberg, 2014; Martin & Thunder, 2013; Shotton et al., 2013; Tierney, 1992) agree in that Native students cannot leave their cultures behind once they enter institutions created for their white[7] peers, and that these institutions have a responsibility to provide culturally relevant experiences.

Persistence factors. In my continued efforts to bring attention to Native student stories of success in engineering, it is important to focus on what the literature currently says in regards to their persistence. Recent research has focused on factors that influence Native student

[7] I choose to not capitalize the word "white" when used to describe racial identity even though the American Psychological Association recommends to do so (Ozias, 2017). Instead, I follow Kimberle Crenshaw's (1991) recommendations in capitalizing terms that represent particular cultural groups and not terms like "white," since that is not representative of a cultural group.

persistence more generally, though not necessarily addressing the differences across major groups. Scholars have emphasized the importance of family support and engagement, supportive faculty and staff both Native and non-Native, peer mentoring programs, and connection to culture through student services and programs (Brown & Robinson-Kurpius, 1997; Lundberg, 2014; Lundberg & Lowe, 2016; Mendez et al., 2011; Shotton et al., 2013; Shotton, Oosahwee, & Cintron, 2007; Waterman, 2007). Martin and Thunder (2013) share an example of connecting to culture as they advocate for involvement of elders in student affairs programs stating they "can bring a sense of comfort, connection, and belonging among Native American students, and strengthen bonds among the university, Native American students, and tribal communities" (p. 43). Additionally, Waterman (2007, 2012) found in her studies with Haudenosaunee (Iroquois) students that regular visits to home for family and cultural obligations led to successful degree completion. Furthermore, Jackson et al. (2003) reported that successful students acknowledged family support and encouragement as a key factor to their persistence. Family support is often not limited to parents, rather it involves extended family members such as grandparents, aunts, uncles, children, and/or cousins (Jackson et al., 2003). Guillory and Wolverton (2008) found in their study of Native American student persistence that family was the most influential factor in motivating students and helping them overcome adversity to succeed in college. For Native American students, "it's all about family" (Guillory & Wolverton, 2008, p. 84).

The connection to place and family continue to play a vital role in college success for Indigenous students. While financial aid is still a crucial component to their going to college, there is a need to move beyond just monetary means of getting students to our higher education institutions, but to retain them by creating ways to connect them with the institution and their home communities (Guillory & Wolverton, 2008; Waterman, 2007, 2012; Shotton et al., 2013).

Embodying a strong sense of cultural identity has also been linked to Native student persistence in higher education (Brayboy, 2005; Chow-Garcia, 2016; Deyhle, 1995; Huffman, 2001; Jackson & Smith, 2001; Kirkness & Barnhardt, 1991; Tachine, 2015; Waterman, 2007). Jackson and Smith (2001) and Huffman (2001) affirmed that Native students can and should resist the notion that their culture is an impediment to their college success, but rather their cultural identity provides a strong foundation for their success. In her study with Haudosaunee students, Waterman (2007) posits that their connection to "culture, community, and family" led to their persistence in college. Furthermore, the previous examples give insight into the unique needs of Indigenous students in higher education, and how institutions can make policy and environmental changes to support their success.

Students of Color in STEM

Given the need to produce more STEM workers, the United States must focus on increasing college access and persistence of minoritized students to fulfill our diverse workforce needs (Hurtado et al., 2008; Museus, Palmer, Davis, & Maramba, 2008; Palmer et al., 2011). Never before has this been more important when projections have Black, Hispanic, Asian, and Native American populations expected to grow rapidly over the next few decades (U.S. Census Bureau, 2008). However, the disproportionately low numbers of African American, Latino/a, and Native American students in STEM fields remain and can be attributed to a number of cultural, structural, and institutional factors (Tsui, 2007). In comparison with their white peers, freshmen students of color are just as likely to enroll in science and engineering studies (Anderson & Kim, 2006; Elliott, Strenta, Adair, Matier, & Scott, 1996; Tsui, 2007); however, they are more likely to switch to non-STEM majors and less likely to complete a STEM degree (Chubin & Babco, 2003; Culotta, 1992; Elliott et al., 1996; Georges, 1999; Morrison & Williams, 1993; Tsui,

2007). Furthermore, the Center for Institutional Data Exchange and Analysis (2000) reported that only 24 percent of underrepresented racial minorities complete an undergraduate degree in science or engineering within six years of initial enrollment, compared to 40 percent of white students. Similarly, the National Science Foundation (2010) states that even though students of color comprise approximately 24 percent of the U.S. population, only 13 percent of students of color earn undergraduate degrees in STEM and 10 percent make up the STEM workforce. Consequently, these alarming statistics express the continued imperative for recruiting and retaining students of color in the STEM fields.

In the vast amount of literature on students of color in STEM, very little focuses on Native student experiences specifically, or they are left out altogether. Consequently, I will next review the current literature that attests to the factors influencing the persistence of students of color in STEM, to include two relevant themes found: holistic support and the impact of tribal colleges and universities (TCUs).

Holistic support. Supportive educational environments during college are positively linked to persistence for minoritized students in STEM education (Byars-Winston et al., 2010; Chow-Garcia, 2016; Hurtado et al., 2007). Palmer et al. (2011) found that peer group support, involvement in STEM-related activities and strong high school preparation were integral to retention and persistence of minoritized students in STEM majors. In a study on students of color in engineering undergraduate programs, Leonard, Pearcy, Shehab, and Walden (2013) found that social networks increase social capital[8] for these students, which in turn, affects their persistence in such majors. Recommendations for supporting students of color in engineering programs

[8] Social capital is defined as the "aggregate of actual or potential resources linked to possession of a durable network of essentially institutionalized relationships of mutual acquaintance and recognition" (Dika & Singh, 2002, p. 33).

included encouraging peer interaction, engagement with faculty of color, accessibility of college information, mentoring programs, scholarships, and frequent meetings with advisors (Leonard et al., 2013).

In alignment with supportive educational environments, Strayhorn (2012) emphasizes how sense of belonging attributes greatly to persistence for students of color in STEM majors. Strayhorn (2012) compiled data from four major projects that included both quantitative and qualitative studies on undergraduate students' sense of belonging in STEM and found that a) sense of belonging is important in STEM; b) mattering – the feeling that one matters and is valued by others – seems to facilitate sense of belonging in STEM; c) not all students experience sense of belonging in STEM equally; and d) intersectionality of social identities affect students' sense of belonging in STEM. His results underscore the valuable importance of students' perceptions of belonging and mattering being an essential piece to their persisting in majors where they are already outnumbered by their white counterparts. Students of color placed particular importance on "belonging experiences" and mattering (Strayhorn, 2012). In sum, Strayhorn (2012) encourages administrators wishing to broaden participation in STEM fields to "nurture their [students of color] connectedness, relatedness, even their psychological need to belong" in order to broaden participation in STEM fields.

Thus far, the literature points to holistic support and assisting students of color in finding their sense of belonging within the academy, and furthermore within engineering programs. However, increasing representation of Native students who are graduating with engineering majors at four-year public institutions remains an issue we have been unable to resolve. With the exception of Chow-Garcia's dissertation work (2016), no other literature exists examining Native student experiences in STEM, and none exist looking at Native students in engineering programs

specifically. Consequently, I feel we must turn to tribal colleges and universities (TCUs) – who emphasize culturally relevant curriculum and Native values at the core of their mission – to understand how we can to increase persistence of Native students in engineering fields.

Impact of TCUs. A few scholars have emphasized the impact that historically Black colleges and universities (HBCUs) and Hispanic-serving institutions (HSIs) have on facilitating sense of belonging and persistence for students of color in STEM (Conrad & Gasman, 2015; Hurtado et al., 2009; Perna et al., 2009). HBCUs have 27 engineering undergraduate programs out of the 533 colleges and universities total that house such programs (Anderson, et al., 2018). This small group of institutions conferred 17 percent of all engineering bachelor's degrees earned by Black students in 2016, with four HBCUs being among the top 10 producers of bachelor's degrees to Black graduates (Anderson et al., 2018). Additionally, HSIs comprise nine percent (or 46 institutions) of the 533 colleges and universities with engineering undergraduate programs (Anderson et al., 2018). One third of engineering bachelor's degrees conferred to Latinx students in 2016 were from HSIs (Anderson et al., 2018).

In Perna et al.'s (2009) study, they utilized case study methodology in observing Black women's experiences at Spelman College, a HBCU for women. The authors found that small class size, ease of student access to faculty offices, presence of a cooperative rather than competitive peer culture, efforts of faculty to encourage and promote student success in STEM, accessibility and use of academic support resources, and the availability of undergraduate research opportunities provided an environment for student success (Perna et al., 2009).

Noticeably left out of the literature are tribal colleges and universities (TCUs), who are making significant contributions to producing Native STEM graduates. TCUs are unique in that majority are located on reservations, are chartered by a particular tribe, and are inextricably tied

to maintaining tribal sovereignty[9] (Guillory & Ward, 2008). TCUs are a prime example of how tribes exercise tribal sovereignty and are able to push back on centuries of assimilation efforts by the U.S. government. What distinguishes TCUs from other minority-serving institutions (MSIs) such as HBCUs and HSIs, is in their origins of being founded by Native people for Native people as a means to maintain our Native identity, language, culture, and sovereignty (Guillory & Ward, 2008; Warner & Gipp, 2009). Many TCUs, due to their foundations and focus on serving tribal communities, are unfortunately designated as a special focus college and that has contributed to the perception that they are inferior to mainstream institutions (Tierney, 1992). Additionally, many are economically and geographically isolated, and most are two-year colleges (Conrad & Gasman, 2015). TCUs currently represent less than 1 percent of higher education institutions yet enroll 10 percent of Native American undergraduates (Conrad & Gasman, 2015, p. 21).

When analyzing the current literature, no scholarly research articles were found to discuss the impact of TCUs on producing more Native American STEM majors. Due to lack of financial resources and faculty having heavy teaching responsibilities with few, if any, research opportunities, the lack of research articles in this area is not surprising (National Academy of Sciences [NAS], 2006; Warner & Gipp, 2009). However, organizations such as American Indian Higher Education Consortium (AIHEC) and the National Science Foundation (NSF) have instituted efforts focused on STEM development at TCUs. I will discuss these programs further.

AIHEC STEM initiatives. One such program that AIHEC administers, in collaboration with AISES, is the American Indian Research and Education Initiative, that provides STEM research and education funding to the nation's TCUs. The program is currently funding three

[9] Tribal sovereignty is a legal and political status granted to tribes after the signing of U.S. government treaties, and refers to tribal nations' right to self-governance, self-determination, and self-education (Guillory & Ward, 2008).

pairs of TCUs and mainstream institutions – Navajo Technical College and Arizona State University; Little Big Horn College and Montana State University-Bozeman; and Sinte Gleska University and South Dakota School of Mines and Technology – to fund student and faculty research teams to bring energy projects to tribal land (AIHEC, 2019b). All projects involve working on tribal reservations to include advancing solar system design and installation on local tribal lands, evaluating opportunities for coal-to-liquid fuel and carbon capture and sequestration technologies projects, and utilizing computer modeling and simulation technologies to identify oil and gas development opportunities (AIHEC, 2019b). Furthermore, AIHEC has a partnership with the U.S. Environmental Protection Agency, called the EPA Tribal ecoAmbassadors that links TCU faculty and students with EPA scientists to seek solutions to environmental issues relevant to tribal communities (AIHEC, 2019b). Each of these projects work to improve tribal communities and their continuing efforts toward sovereignty.

NSF Tribal Colleges and Universities program. The National Science Foundation (2018) recently launched a Tribal Colleges and Universities Program (TCUP), where they awarded $14 million to TCUs to establish four new Tribal Enterprise Advancement (TEA) centers to build scientific and engineering expertise at TCUs to provide intellectual resources for tribes and communities. The centers will address environmental, social, educational, and economic challenges and promote community-relevant opportunities. The focus of each of the centers are on marine matters, manufacturing technology, water research studies, and training and assistance to tribes in planning and managing multiple resources. The support funding from NSF has led to significant growth in TCU STEM degree offerings that are relevant to students' interests, cultures and environments, undergraduate research opportunities, and challenging mathematics courses.

What differentiates these efforts from other U.S. polices and STEM diversity efforts are their specific focus on the relevant needs of tribal communities for purposes of self-determination and sovereignty. Tribal college students in the STEM fields are "grounding their scientific research within their homelands and breaking ground by pushing boundaries, solving problems, and exploring questions that benefit the nation" (AIHEC, n.d., p. 3). These federal programs are putting resources toward culturally relevant programs to support TCUs and mainstream institutions in these collaborative efforts. Efforts on connecting engineering majors with these culturally relevant projects must be communicated effectively in order to recruit and retain Native students to these majors. Federal financial resources must be committed to these relevant research opportunities in order to increase Native student participation in engineering majors at NNCUs.

However, TCUs still struggle to provide these undergraduate engineering research opportunities. TCUs have traditionally not offered engineering major opportunities, where undergraduate research opportunities are often the pinnacle for retaining students of color in STEM fields (Strayhorn, 2010), while mainstream institutions continue to fail to graduate many Native students in engineering. Consequently in the summer of 2002, leadership of the All Nations Louis Stokes Alliance for Minority Participation (ANLSAMP) heeded the call to create a working group to develop, implement, and sustain engineering studies at TCUs (NAS, 2006). The purpose was to put the responsibility on the TCUs to graduate Native American students with engineering degrees, where the curriculum can be culturally relevant to tribal students, and thus, reducing the high attrition rates of Native students at mainstream institutions (NAS, 2006). The invitation to be a part of this working group was sent to all TCUs, of which 11 (about one-third of TCUs at this time) responded and formed an informal partnership toward these efforts in

June 2003: Blackfeet Community College (Montana); Chief Dull Knife College (Montana); College of Menominee Nation (Wisconsin); Crownpoint Institute of Technology (New Mexico); Fort Berthold Community College (North Dakota); Haskell Indian Nations University (Kansas); Salish Kootenai College (Montana); Sitting Bull Tribes Technical College (North Dakota); Southwestern Indian Polytechnic Institute (New Mexico); United Tribes Technical College (North Dakota); and White Earth Tribal and Community College (Minnesota) (NAS, 2006).

With a goal of implementing a bachelor of science in engineering program, only one TCU to date has done so. Salish Kootenai College in Montana now offers a bachelor's degree in computer engineering (AIHEC, n.d.). However, there are several TCUs that offer best practices in STEM programming. I will touch on a couple of monumental programs that showcase how they implement cultural relevance into STEM curriculum.

Chief Dull Knife College. Located on the Northern Cheyenne Indian Reservation in southeastern Montana, Chief Dull Knife College has a unique math emporium that has not only eased fears of math for many Native students, but has engaged them in self-paced learning (Conrad & Gasman, 2015). Faculty and staff have created a safe space through computer-assisted, collaborative learning and by cultivating personal relationships with students (Conrad & Gasman, 2015). Along with instant feedback from the computer-based curriculum, students also receive assistance from instructors and peer tutors one-on-one as they achieve mastery on each topic at their own pace (Conrad & Gasman, 2015). Faculty members integrate the computer-assisted learning into their classrooms as they give a lecture and then allow the student to practice online, and they can complete the lesson later at home or in the math lab, which is staffed throughout the day (Conrad & Gasman, 2015). The flexibility with the computer-assisted

programs allowed for Native students to learn on their own time when family obligations arose, and the faculty moved at a pace that they could manage (Conrad & Gasman, 2015).

The key to the math emporium's success is the faculty-student relationships and their connection of the material to real-world problems (Conrad & Gasman, 2015). The faculty take time to get to know each one of their students, and encourage them throughout this learning process to move them beyond feeling like "lifelong failures at mathematics," or what they call "math shame" (Conrad & Gasman, 2015, p. 45). Additionally, the instructors make problems relevant to their lives by having them calculate cost of replacing flooring in their house after examining a floor plan, or teaching number theory using cultural artifacts from Native cultures (Conrad & Gasman, 2015, p. 47). While solving these problems, they move between working collaboratively and individually until they all master each topic. This approach builds community amongst the faculty and students in an applicable and culturally relevant way.

Salish Kootenai College. Based in Pablo, Montana on the Flathead Indian Reservation, Salish Kootenai College (SKC) serves the Bitterroot Salish, Kootenai, and Upper Pend d'Oreille tribes (Conrad & Gasman, 2015). At Salish Kootenai College, students are engaged in science education centered around a Native paradigm that addresses issues of concern to Indigenous peoples (Conrad & Gasman, 2015). Faculty explain their science programs as "designed to show TCU students how STEM is relevant to their lives and at the same time to stimulate their interest in using STEM – especially environmental and life sciences – to sustain their communities" (Conrad & Gasman, 2015, p. 63). Centralizing topics around relevant issues in their geographic areas and communities, as well as incorporating Native ethical values of respecting living things allows the students to make the connection to their cultural identity (Conrad & Gasman, 2015).

While faculty-student relationship plays a key role in student success at SKC, the supportive network of peers and STEM professionals, and academic apprenticeship take the support a step further. Faculty are intentional in making the classes and cohorts small to provide a nurturing learning environment (Conrad & Gasman, 2015). One faculty member interviewed on the program elaborated on the apprenticeship:

> …the institutional commitment to a hands-on, laboratory research-based approach required SKC programs to teach STEM concepts and processes in the context of real research projects, always in small classes and frequently by way of year-round, credit-bearing paid internships…as students build robots or study mercury levels in local fish and wildlife, they find personal educational and career goals that stand a better chance of motivating them to learn STEM concepts and processes – especially in overcoming issues with the "old enemy," math. (Conrad & Gasman, 2015, p. 69)

What the faculty described is a form of undergraduate research, which has been found to an effective means for attracting and retaining science majors (Strayhorn, 2010). The one-on-one attention and culturally relevant topics make an immeasurable impact on the student and their tribal communities. Conrad and Gasman (2015) further support their model by indicating that their graduation rates in STEM programs at SKC was 55 percent in 2011, which was far above the national average (p. 73).

MSIs continue to produce the largest number of students of color with STEM degrees (Whittaker & Montgomery, 2012); thus, they have much to teach mainstream institutions about integrating culturally relevant practices that contribute to the persistence of students of color in these fields. In reference to Native student persistence, TCUs have much to teach NNCUs in creating more culturally relevant STEM programs. More importantly, they choose not to

sacrifice cultural identity or their educational goals, and provide ways to connect non-Western and Western cultures, preparing students to support their home communities and contribute to the greater society (Conrad & Gasman, 2015). Not surprisingly, students of color view MSIs as inclusive and empowering, which often influences their concern for their peers' success and persistence (Conrad & Gasman, 2015). According to an AIHEC report (n.d.), TCUs have demonstrated success within STEM education through "culturally responsive teaching methods in mathematics" and "teaching authentic and meaningful science to students of all levels" (p. 3). NNCUs are described as producing a "chilly campus climate" for students of color in STEM, specifically in the classroom, which has been linked to their attrition in these fields (Cabrera, Colbeck, & Terenzini, 2001).

The current limited research on MSIs emphasize the importance of faculty-student relationships, peer mentoring programs, summer bridge programs, and undergraduate research opportunities to produce significant outcomes for students of color in STEM (Conrad & Gasman, 2015; Flower III, 2014; Griffin, Perez, Holmes, & Mayo, 2010; Palmer et al., 2011; Perna et al., 2010; Shotton et al., 2007; Tsui, 2007). Additionally important to note is that the small amount of literature that exists on TCU contributions to STEM are largely written by non-Indigenous scholars. This problematic fact continues to invisibilize Indigenous contributions to STEM, Indigenous knowledge systems, and undermines the immense contributions TCUs continue to make on graduating and preparing Indigenous students in STEM studies. Nelson (2017) argues that the "missing Native narrative and lack of data availability is not a negative reflection of TCUs, but rather a challenge and opportunity that institutions like TCUs face when establishing a foothold in the higher education landscape" (para. 3). The invisible data can continue to invalidate TCUs as major contributors to educating Indigenous students in STEM, and their ways

of knowing and conducting research in a manner that can contribute to the revitalization of sovereign tribal nations. The lack of data continues to perpetuate the dominant narrative of TCUs being "less than" NNCUs, or Native communities as being deficient. Consequently, there continues to be a call for Indigenous scholars to gather this data and contribute to the literature on their own communities, rather than non-Indigenous scholars attempting to do it for them, and misinterpreting their experiences and contributions.

Native Students in STEM

While the current research on students of color in STEM can be helpful in generalizing to all minoritized groups studying STEM, it is important to point out that most of the literature excludes and ignores Native students and their experiences. Consequently, higher education institutions, particularly mainstream or non-Native institutions, continue to struggle in the recruitment and retention of Native students in STEM fields, but particularly in engineering. In 2014, Native Americans earned the least amount of all science and engineering bachelor's degrees with 0.5 percent awarded and are represented even more disparingly in engineering bachelor's degrees with 0.3 percent awarded (NSF, 2017a). As demonstrated in Table 2.1, American Indian/Alaska Native students consistently make up the lowest percentage of the population in graduating with engineering degrees and are the least represented in overall degrees conferred. Furthermore, American Indian/Alaska Native students were the only racial and ethnic group to experience a decrease in the number of bachelor's degrees awarded in engineering from 2011 to 2016 (Anderson, Williams, Ponjuan, & Frierson, 2018). The decline in engineering bachelor's degrees awarded follows a larger trend among this group, as the number of non-engineering bachelor's degrees for American Indian/Alaska Native students also declined by 19 percent from 2011 to 2016 (Anderson et al., 2018). Enrollment at four-year colleges and

universities also saw a significant decline at 23.3 percent from 2010-2016 (Anderson et al., 2018).

Table 2.1. Percentage Distribution of Engineering Bachelor's Degrees Awarded Compared to Total Bachelor's Degrees Conferred by Race/Ethnicity, 2014-15

Race/Ethnicity	*Percentage*	*Total Degrees Conferred*
American Indian or Alaska Native	0.3%	0.5%
Hispanic or Latino	9.6%	11.5%
Asian	10.7%	7.1%
Black or African American	3.8%	10.2%
White	61.5%	63.9%

Source: NSF (2017a); NCES (2017)

As previously mentioned, often times Native students represent such a small number that they are deemed insignificant and often denoted with an asterisk (Shotton et al., 2013). The scarce research focusing on Native American undergraduate experiences in STEM lags behind research focused on Hispanic/Latinx, African American, and women's experiences (Demmert, Grissmer, & Towner, 2006; Foor & Shehab, 2009). While research is necessary on all students of color in these fields, it is discouraging when Natives have been continuously left out of the research, which is why we know so little about the experiences of the few who persist in engineering. The little we do know from the sparse research expresses two major themes in regards to Native students matriculating to and persisting in STEM majors: 1) that there is typically a dissonance in Westernized practices of STEM education versus traditional Indigenous

ways of knowing, and 2) that Native students typically enjoy majors that embody communal goals. A review of the literature around these two themes will be further discussed below.

Dissonance in epistemologies. A few scholars (Chow-Garcia, 2016; Lee Bitsoi & Lowe, 2018; Lundberg, 2007; Seymour & Hewitt, 1997; Smith et al., 2014) have noted that there may still be a dissonance between the Western practices of STEM education and Indigenous ways of knowing that prevent their matriculation to these majors. STEM epistemologies have always been a part of our world, but different words or concepts may be used that do not translate to English, nor are they acknowledged in our Westernized systems of education (Lee Bitsoi & Lowe, 2018). Moreover, Native people have and continue to rely on oral traditions as ways of passing down knowledge through generations, which is why most people are not aware that STEM is not new to us and has been a part of Indigenous cultures for centuries (Brayboy, 2006; Lee Bitsoi & Lowe, 2018). Lee Bitsoi and Lowe (2018) share vivid examples of how STEM has been integrated into Indigenous cultures in a multitude of ways:

> Science is taught with ethnobotany through the use of plants for medicinal or artistic use. Biology is present in the agronomy and agricultural techniques of Native people, most notably in the practice of planting corn, beans, and squash next to each other. Technology can be found in the manner in which Native people use natural waterways to design and utilize irrigation canals for their farms. Engineering can be found in the architecture of homes and ceremonial structures – the portable teepee or traditional Navajo Hogan. Math can be found in the traditional counting systems of Indigenous people through pictures or knots on a counting rope. Anatomy and physiology are taught in the butchering of a deer, sheep, or buffalo. Astronomy and cosmology are also crucial to the way Native people tell the changing of the seasons and forecast weather. (p. 88)

These ways of knowing were not published as they have been passed down orally through generations of Native people. Due to this disconnect from the Westernized ways of passing down knowledge, our ways of knowing are often questioned and deemed illegitimate, which may also contribute to why we are not seeing Native students pursue and persist in STEM degree pathways.

The few studies that exist on exploring Native American student experiences in STEM highlight the importance of relevance to their community in choosing their career paths, as well as creating a communal environment in these technical majors when on campus. In Shehab, Walden, and Wellborn's (2015) study of students of color at one large research institution in Southwest U.S., they found that Native American students primarily noted interest in engineering and social supports to have the highest influence on engineering major choice. Additionally noteworthy was that Native students were minimally motivated by social recognition, being influenced the least from that category. Furthermore, Shehab et al. (2015) emphasized early exposure to engineering through everything from small events to STEM-focused high schools and curriculum, educating students on relevant employment prospects and the high demand for engineers in the workforce, and access to knowledgeable high school counselors and teachers as being important to their engineering career choice.

In understanding that cultural relevance is important to Native students in career choices, it should not be surprising that giving back to our community is at the epicenter of who we are and what we choose to do in life. With that in mind, one of the most common themes found in the sparse literature on Native students' matriculation and participation in STEM majors was the importance of communal goals. Often times, this is contrary to the competitive and individual cultures of Westernized academic institutions, and particularly in engineering majors. As noted

previously, family support and involvement is a key factor that has been shown to influence Native student success in higher education (Jackson, Smith, & Hill, 2013). Consequently, communal goals – or the importance of the collective – is at the forefront of importance in Indigenous students' major selection and persistence in college.

Communal goals. In Smith, Metz, Cech, Hunatoon, and Moyer's (2014) study of Native first-year students in science and engineering programs, they found a strong link of students who grew up in traditional tribal communities with communal goals of specifically wanting to preserve and contribute to their tribal communities for their motivation in pursuing these degrees. Belonging amongst their STEM peers was found to be most important for those who did not grow up in traditional tribal communities (Smith et al., 2014). Additionally, those with the strongest sense of belonging were well-integrated into Native American student support programs (Smith et al., 2014), which supports earlier research on general Native student success (Martin & Thunder, 2013; Shotton et al., 2013).

Accordingly, Smith et al. (2014) recommend "reshaping the culture of STEM to one that integrates and values communion" (p. 424), which would be more inclusive of an Indigenous perspective. Conrad and Gasman (2015) further support STEM practices that relate to Indigenous communities by discussing best practices from a tribal college that emphasizes the Native worldview and applicability of STEM to tribal communities through the clustering of science programs and undergraduate research on relevant issues. Much of the dissonance between Indigenous communities and STEM is not having a clear understanding of how these professions are beneficial to society and tribal communities (Miller, 2010; Tsui, 2007). Consequently, NNCUs should look to MSIs, and particularly tribal colleges and universities, for

guidance on creating culturally relevant curriculum and more supportive climates for Native students.

With a review of the history of Native American education, the barriers and support for Natives in higher education, and persistence factors for students of color and particularly Natives in STEM set forth, the review of literature will next shift to a brief overview of foundational student retention theories. Discussion will then move to a selection of culturally relevant theories of student retention for Indigenous students.

Culturally Relevant Retention Theories

Tinto's theory of student departure (1987, 1993) became one of the pinnacle theories on student retention decades ago. In spite of this contribution, what remains is the need to address the unique needs and experiences of Indigenous students. Tinto's theory suggests that students enter college with an array of personal, family, and academic skills with specific intentions regarding career goals and college attendance. Students then adjust these intentions as they engage with individuals, structures, and members of the college or university community. Furthermore, positive interactions lead to integration into the campus community and retention, whereas negative interactions lead to feelings of alienation and marginalization, leading to student departure from the institution. Consequently, Tinto determines that student departure occurs when there is a misalignment with student's pre-entry intentions and goals and the campus environment. Many scholars have challenged Tinto's theory of student departure and raised the need to look at the specific needs of Indigenous students (Tierney, 1999; Waterman, 2007; Youngbull, 2018). Youngbull's study (2018) with American Indian Gates Millenium Scholars revealed that Native students do not always take a linear path in their educational journeys, often times attending more than one college throughout their experience. Furthermore,

Waterman (2007) found in her work with Haudosaunee students, that many took almost eight years to complete a bachelor's degree, attending more than one college along the way. Tierney (1999) criticized Tinto's original theory of student departure for his exclusion of the cultural conflict experienced by students of color. Tierney (1999) has noted that Tinto encourages a form of cultural suicide, whereby students of color must take a break from the communities they were raised in to fully assimilate into the dominant culture of the colleges they attend. Consequently, Tierney (1999) argues that Tinto is contending that if students assimilate they will be successful, whereas if they fail to assimilate, they will ultimately fail at college.

Tinto (2006) has since recognized the distinguishing differences for students of color and their need to remain connected to their communities while on campus to persist to degree completion. However, it is important to acknowledge the cultural insensitivity and exclusion of the experiences of students of color by what is considered such a foundational theory in the academy (Chow-Garcia, 2016). It is also necessary to attend to the specific experiences of Native, Black, Latinx, Asian, and other marginalized groups. Fortunately, the literature has since evolved to include some culturally relevant perspectives and theories, and some specifically inclusive of Indigenous knowledge and perspectives in order to retain Native American students (HeavyRunner & DeCelles, 2002; Huffman, 2001; Kirkness & Barnhardt, 1991). Two of these culturally affirming theories will be discussed further below.

Theory of Transculturation. Huffman's (2001) theory of transculturation evolved to address the unique needs of Indigenous students in how they interact with higher education, and thus, persist to graduation. In his study, Huffman (2001) identified four "cultural masks," which are used to symbolize how an individual constructs a personal ethnic identity. These "cultural masks" include the assimilated student, marginal student, estranged student, and the

transculturated student. Huffman (2001) determined that the transculturated student experienced the most difficult and complex collegiate journey, developing in four stages: initial alienation, self-discovery, realignment, and participation. Through these stages, students move from cultural conflict with the Westernized ways of the institution, to learning to straddle both ways, and then finally transcending their Native American heritage as a source of confidence and strength (Huffman, 2001).

Huffman's theory of transculturation (2001) was instrumental in emphasizing the importance of cultural integrity and identity in Native students' persistence at mainstream institutions. Consequently, he proposes three important features or assumptions of transculturation: 1) a strong cultural identity is essential; 2) cultural exchanges enhance learning processes rather than creating a cultural hybrid project; and 3) transculturation is a complex process that results in the ability to participate in two different cultural environments (Huffman, 2010). Chow-Garcia (2016) compared this experience to that of studying abroad, whereas students enhance their own cultural understanding, yet they maintain their American cultural identity. Native students often do live in two worlds at mainstream institutions, but with a strong sense of identity and purpose, they can persist.

Family Education Model. HeavyRunner and DeCelles (2002) developed the Indigenous-based Family Education Model (FEM) after conducting research at five tribal colleges in Montana. The intervention-based model suggests that students' replication of the Indigenous extended-family structure within the college environment enhances students' sense of belonging and consequently leads to student retention. The FEM is truly the first of its kind at a postsecondary institution, with its focus on "family support, empowerment, and American Indian values (HeavyRunner & DeCelles, 2002, p. 33). Additionally, the FEM was the first to recognize

previous tribal college enrollment as a factor for retention of Native students matriculating to mainstream institutions (HeavyRunner & DeCelles, 2002).

HeavyRunner and DeCelles (2002) noted that three assumptions predicated the development of the FEM: 1) many students and families need the college to act as a liaison to social and health services during times of crises; 2) tribal colleges must structure the campus community for families to support student efforts; and 3) tribal colleges must engage family members in student activities on campus. Consequently, these three assumptions led to the development of strategies to assist post-secondary institutions in implementing this model. However, since this model has been utilized primarily in tribal college settings, the usage at mainstream institutions has been limited within a specific program and not yet at the level of broader institutional retention initiatives (Tachine & Begay, 2013).

From Tinto's foundational theory of student retention to more culturally relevant theories, such as Huffman's theory of transculturation and HeavyRunner and DeCelles' Family Education Model, theories of student retention have evolved to begin recognizing the unique needs of Native American students. While generalization may still be challenging due to the multitude of experiences of Native students from various backgrounds from one or more of the 567 federally recognized tribes, it is still important to note the threads of similar experiences and offer various approaches to retaining and graduating Native students at our higher education institutions.

Summary

From understanding the tumultuous history of Native American education to current barriers to access and persistence factors for Native students in higher education, one can see the need for more research with Indigenous communities in regards to the Native student experience.

Coupled with the alarming statistics of Native student (under)representation in higher education in general, and in engineering programs specifically, this research is vital to the survival of our nation and our tribal communities. The current scholarship in this understudied area groups many minoritized experiences together or is quantitative in nature, which disregards the rich stories of Indigenous student experiences in undergraduate engineering programs. Research with Native students persisting in engineering programs is nearly non-existent. The overview of retention theories shares the evolution from groundbreaking foundational theories to more culturally relevant models, though more are necessary to address the diverse demographics and backgrounds of our Indigenous students. Since retention of Native students is still a major issue, it is difficult to determine whether non-Native institutions are aware of and/or utilizing these models. Non-Native institutions must prioritize Native student success at the institutional level before the effects are noticeable at the academic program level. Consequently, further research to explore Indigenous students' experiences in engineering programs may be groundbreaking in gathering their attention toward this national deficit.

This chapter situates Native American college students within the broader context of higher education research and gives an overview of the current barriers and support structures currently working for our Indigenous students. Through this literature review, an emphasis on both cultural and academic support is emphasized, a collective over the individual perspective is presented, as well as a critical review of current theories on student development. The following chapter expands on the literature and conceptual framework to explore the methodology utilized in this study and how it contributes to a more inclusive perspective on understanding Indigenous student experiences in engineering programs, as well as problematizing current social, political,

and historical structures on our college campuses.

Chapter Joi (Three): Methodology

This chapter presents the conceptual frameworks and methodological approach for this study and my intentions for centering my approach in an Indigenous way. Wilson (2008) describes the Indigenous research agenda as one where the "researcher has a vested interest in the integrity of the methodology (respectful) and the usefulness of the results if they are to be of any use in the Indigenous community (reciprocity)" (p. 77). My desire is to advance ideas of self-determination, sovereignty, and nation-building by understanding Indigenous engineering student stories of persistence. The chapter begins with my rationale for an Indigenous approach, as well as an introduction to my conceptual frameworks and methodology. The research questions guiding the study are subsequently introduced, followed by an overview of my conceptual frameworks, how participants were selected, and how subsequent data was collected and analyzed.

Introduction

Over the last ten years, there has been a surge of Indigenous scholars producing Indigenous research methodologies and frameworks (Archibald, 2008; Brayboy, 2006; Kovach, 2009; Minthorn & Shotton, 2018; Smith, 1999; Tachine, 2015; Wilson, 2008), which has empowered us future Indigenous scholars to reclaim our research spaces, and has fostered a community of support and affirmation for this critical work. Most recently, Minthorn and Shotton (2018), in collaboration with many other Indigenous scholars, published a book entitled, *Reclaiming Indigenous Research in Higher Education,* to further push for Indigenous scholarship while showcasing many examples of such work both qualitatively and quantitatively. Reading this collective of diverse Indigenous scholars' research utilizing Indigenous methodologies to work with Indigenous communities reinforces the need to push against the colonizing foundation

of higher education research, and assert my own Indigenous epistemology, ontology and methodology into this work. As Brayboy (2018) states that "Indigenous methodologies are ones of presence," and that this presence "is a form of resistance, resilience, resurgence, restoration, and repatriation" (p. xi). It is for my ancestors, for these amazing Indigenous scholars who have come before me, and for those future Indigenous scholars who will come after me, that provide me purpose in my ways of conducting this research. As a collective, we are much more powerful.

Centering this study through an Indigenous lens with a decolonizing purpose, I choose to employ *stories* as the epicenter of my research methodology. When I say stories, I do not just mean any story, but I mean Indigenous stories. Stories, for us, have served as a vital life source of our existence. Our oral stories have served as the vessel through which we transmit knowledge from one generation to the next as a people. These stories have played a major role in the survival of our cultural and spiritual practices through the attempted erasure of many of our tribal nations. While working through this colonized process of the academic dissertation, I struggled with finding an epistemological and methodological space where I belonged. While this process is very isolating, even more so as an Indigenous person in a predominantly white academy, I sought empowerment and support from my sisters and brothers in the program. I wanted to find an approach that would honor my family, my ancestors, and pave the way for future generations of Indigenous students, as well as continuing to dismantle settler paradigms and continue to decolonize my own paradigm.

Once I read Jo-Ann Archibald's *Indigenous Storywork,* I knew I had found the methodology that aligned well with my epistemology and ontology as a Native person, as well as one that would share my participants' stories through an Indigenous lens. Archibald (2008)

introduced a methodological approach that speaks to Indigenous people across tribal identities, and seeks to privilege Indigenous knowledge and stories as a legitimate source of data in the Westernized academy. While learning more about Indigenous Storywork, I reflected on one of the Cherokee origin stories of the earth as a great floating island surrounded by water. The earth came to be when Dâyuni'sï, the little water beetle, came down from Gälûñ'lätï, the sky realm, to see what was below the water. He dove to the bottom of the water and began bringing up mud that expanded in every direction and became the earth. Through water beetle's efforts and the efforts of many other animals, it was then transformed into the lush valley homelands in present-day North Carolina. I tell this story to emphasize how our stories as Indigenous people, allow us to understand beginnings and make meaning of the present in relation to the past. They are imperative to our ways of knowing and passing down of information from generations to generations. Consequently, in my efforts to reclaim our ways of knowing and gather stories responsibly, this study utilizes two Indigenous-centered conceptual frameworks of Tribal Critical Race Theory (Brayboy, 2006) and Indigenous research paradigm (Wilson, 2008), and then turns to *Indigenous Storywork* (Archibald, 2008) as my methodology to understand and empower the lived experiences of Native undergraduate students persisting in engineering.

Research Questions

To provide further insight into Native student experiences in undergraduate engineering programs, I want to address the research questions once again. My central research question is what are the lived experiences of Indigenous students persisting in engineering undergraduate programs at four-year, public non-Native colleges and universities? This study will additionally seek to address the following sub-questions:

1 What were the students' pre-collegiate pathways to pursuing an engineering degree?

2 What is motivating and supporting Indigenous students to persist in engineering majors at four-year, public non-Native institutions?

3 How can these lived experiences guide how we as student affairs professionals can better create a supportive community for our Indigenous students in engineering programs?

4 How can we work to promote engineering careers for the betterment of tribal communities and sovereignty?

Furthermore, the next section will introduce my blended conceptual frameworks that continue to center Indigenous perspectives.

Conceptual Framework

This section describes the frameworks selected to inform the research by introducing and explaining the applicability of Tribal Critical Race Theory (Brayboy, 2006) and Indigenous Research Paradigm (Wilson, 2008). Tribal Critical Race Theory (TribalCrit) acknowledges the historical trauma inflicted on Native Americans through educational and social contexts throughout history and the key role colonization plays in maintaining the status quo. Wilson's (2008) Indigenous Research Paradigm highlights the importance of *relationality* in our identity as Indigenous peoples with the land, the cosmos, people, and ideas, and how all they are all interconnected. Both paradigms acknowledge stories as legitimate tools for research, place Natives at the epicenter of the educational discourse, and provide hope for the future of our tribal communities. The fact that these theories account for Native teachings and values make these frameworks extremely valuable to my study. I hope to empower our Native students to embrace their unique intersectional identities as strengths to pursue and persist through engineering programs in college.

Tribal Critical Race Theory

Tribal Critical Race Theory provides a framework for understanding the experiences of the men and women in my study. TribalCrit emerged from Critical Race Theory (CRT), which is considered "opposition scholarship" (Calmore, 1992; Brayboy, 2006). CRT was a scholarly legal movement that emerged from a collective understanding that the law had to be understood through race and white supremacy (Delgado & Stefancic, 2000). As CRT developed out of the field of law, specifically Critical Legal Studies, it has since drawn upon other disciplines such as feminism and Marxism (Delgado & Stefancic, 2001; Dixson & Rousseau, 2006). CRT has important aspects that include racism being endemic to American life; its expressing skepticism toward dominant legal claims of neutrality, objectivity, colorblindness, and meritocracy; its challenging ahistoricism and insists on a contextual/historical analysis of the law; its insisting on recognition of the experiential knowledge of people of color and our communities of origin in analyzing law and society; and its work toward the end of eliminating racial oppression as a part of the broader goal of ending all forms of oppressions (Matsuda et al., 1993, p. 6). Additionally, CRT emphasizes the importance of personal narratives and validates them as important sources of data.

CRT was introduced into education scholarship in the mid-1990s to examine the struggles of students of color within institutions of education (Ladson-Billings & Tate, 1995). CRT in education challenges the notions of colorblindness and meritocracy and believes that racism is normalized in society. Holistically, CRT in education aims provides a unique lens to analyze the relationship between students of color and educational institutions to promote equality within the structure of higher education.

While CRT provides an adequate framework for understanding race and racism in society and education, a major critique of the theory is that it is situated in the black/white binary, which does not address all people of color or women. Yosso (2006) explains that the black/white binary "limits understanding of the multiple ways in which African Americans, Native Americans, Asian/Pacific Islanders, Chicanas/os, and Latinas/os continue to experience, respond to and resist racism and other forms of oppression" (p. 170). As it evolved and sought to address such critiques, CRT has now expanded to incorporate the experiences of women with FemCrit, Latinx people with LatCrit, Native people with TribalCrit, and Asian American people with AsianCrit (Yosso, 2006). These branches of CRT more adequately address each groups' historical and current experiences with dominant systems and institutions.

In contrast to CRT, TribalCrit goes beyond the notion that racism is endemic to society in addressing its central tenet that "colonization is endemic to society" (Brayboy, 2006, p. 429). Developed by Lumbee scholar Bryan Brayboy in 2006, TribalCrit unmasks how historical colonization has affected Indigenous peoples, and how these structural forces continue to shape sociocultural spaces, and particularly education. While Brayboy (2006) acknowledges CRT's important contributions as a framework, he notes its limitations in regards to colonization as it particularly relates to Indigenous peoples. Colonization is essentially about one group having power over another with the aim of transforming the identity of a group of people to destroy their autonomy and assimilate them to dominant paradigms. Furthermore, since Indigenous peoples also identify as members of tribal sovereign nations, there is an added layer of complexity in regards to our historical relationship with the U.S. government and distinctions within these tribal nations that CRT is unable to address. TribalCrit sought to encompass the specific needs of

Indigenous peoples as politicized and racialized beings, making it ideal for addressing the stories of the men and women in my study (Brayboy, 2006).

Brayboy's (2006) theory transformed the way we view race and racism in education in regards to Indigenous peoples. TribalCrit offers nine tenets that address the unique experiences and status of Native people:

1. Colonization is endemic to society.

2. U.S. policies toward Indigenous peoples are rooted in imperialism, white supremacy, and a desire for material gain.

3. Indigenous peoples occupy a luminal space that accounts for both the political and racialized natures of our identities.

4. Indigenous peoples have a desire to obtain and forge tribal sovereignty, tribal autonomy, self-determination, and self-identification.

5. The concepts of culture, knowledge, and power take on new meaning when examined through an Indigenous lens.

6. Governmental policies and educational policies toward Indigenous peoples are intimately linked around the problematic goal of assimilation.

7. Tribal philosophies, beliefs, customs, traditions, and visions for the future are central to understanding the lived realities of Indigenous peoples, but they also illustrate the differences and adaptability among individuals and groups.

8. Stories are not separate from theory; they make up theory and are, therefore, real and legitimate sources of data and ways of being.

9. Theory and practice are connected in deep and explicit ways such that scholars must work towards social change (pp. 429-430).

While the first and core tenet of colonization being endemic to society has been previously discussed, the second tenet expands upon this notion in addressing U.S. governmental policies as being "rooted in imperialism, white supremacy, and a desire for material gain" (Brayboy, 2006, p. 431). Brayboy (2006) notes the concept of Manifest Destiny as playing an integral role in the justification for the removal of Indigenous peoples for the conquest of their lands. The third tenet hones in on the racialized and politicized identities nature of Indigenous identities. Brayboy (2006) asserts how colonization has played into the larger society's view of Indigenous peoples as emphasizing our racialized identity and ignoring our politicized identities as members of sovereign nations. This leads into the fourth tenet's examination of Indigenous peoples' right to self-determination and sovereignty. While tribal nations are more recently exercising their right to lead their nations in their own ways, the struggle continues in regards to maintaining land and water resources. This understanding leads to a more thorough analysis of the relationship of Indigenous students and institutions.

The fifth tenet moves away from western notions of culture, knowledge, and power toward a more fluid and Indigenous understanding of the concepts. The sixth tenet addresses the problematic goal of assimilation as being foundational in governmental and educational polices toward Indigenous peoples. TribalCrit rejects assimilation within higher education institutions, and argues for Indigenous students to maintain pride in their cultural identity, arming themselves with both cultural and academic knowledge "to actively engage in survivance, self-determination, and tribal autonomy" (Brayboy, 2006, p. 437). The seventh tenet emphasizes the value of tribal knowledge, philosophies, beliefs, and traditions, recognizing that our ways of knowing are vital for "self-education and self-determination" (Brayboy, 2006, p. 438). This is tied to the eighth tenet that acknowledges the legitimacy of oral stories as sources of data and

theory, challenging the academy's notion of scientifically-based research being the only legitimate form. The final tenet of TribalCrit is rooted in activism much like CRT, in that the result of the research must be relevant to the community, moving beyond an abstract approach. In summary, TribalCrit aims to expose the tensions between western and Indigenous values and ways of knowing, further acknowledging how these tensions affect Indigenous peoples' relationship with inequitable structures such as educational institutions.

TribalCrit provides a relevant lens through which to explore the lived experiences of Indigenous undergraduate students in engineering programs at NNCUs. TribalCrit also provides a lens in which to address issues of racism and colonization for Indigenous students, which is an important aspect in examining educational experiences and hegemonic systems. The theory aligns well with my methodological approach of Indigenous Storywork as it "values narrative and stories as important sources of data" (Brayboy, 2006, p. 428). I believe it will add depth to my analysis in truly understanding what our Indigenous students may be experiencing at their non-Native institutions as both racialized and politicized beings. Additionally, TribalCrit acknowledge the importance of allowing a space for the men and women in this study to share and give meaning to their experiences.

Indigenous Research Paradigm

Central to guiding my research is Wilson's (2008) Indigenous Research Paradigm, which is guided by the interconnectedness of all things. Wilson (2008) notes that "research itself is a sacred ceremony within an Indigenous research paradigm, as it is all about building relationships and bridging this sacred space" (p. 87). Indigenous research paradigm was developed through four stages. The first stage occurred during the assimilationist period (1940-1970) when a small group of Aboriginal scholars entered mainstream education through situating themselves in a

western framework in order to have their work accepted in the academy (Wilson, 2008). As Wilson (2008) explains, the Aboriginal scholars who found research positions in the academy either believed in the dominant system perspective or kept their academic lives separate and in contrast to their Indigenous worldviews. This led directly into the second phase where an Indigenous paradigm began to emerge, but was still heavily influenced by the dominant paradigm to avoid marginalization. Wilson (2008) describes this era as one where Indigenous scholars struggled to be accepted.

Decolonization was the focus of the third stage of the development of an Indigenous research paradigm. Best articulated through the work of Maori scholar Linda Tuhiwai Smith in *Decolonizing Methodologies* (1999), this stage marked the disruption of western methodologies, where she challenged western methods and researchers who studied Aboriginal people (Wilson, 2008). Her efforts sparked a movement of asserting Indigenous epistemologies and methodologies in research. The unwavering belief that Indigenous peoples have their own worldviews paired with the understanding of the effects of colonization led to the current stage in the development of Indigenous research paradigm.

The fourth and final development stage has allowed Indigenous researchers to honor and illuminate their own worldviews throughout their research in the academy (Wilson, 2008). Now, Indigenous scholars are challenged to articulate their own research paradigms, approaches to research and data collection methods, which has led to an increase in Indigenous scholars entering the academy. This final stage truly shifted to one of liberation in Indigenous researchers working with Indigenous communities to articulate research in a relevant and respectful way. Furthermore, this led to a shift in terminology from Aboriginal to Indigenous, to "encompass the underlying systemic knowledge bases of the original peoples of the world" (Wilson, 2008, p. 54).

Throughout this paradigm, knowledge is considered communal and not individual in nature as is commonplace in westernized versions of knowledge formation. As Wilson (2001) states, "knowledge is shared with all of creation" and "you are answerable to *all* your relations when you are doing research" (p. 177). Once we acknowledge that knowledge is not individually owned, Wilson (2008) states that "collaboration in the interpretation of knowledge becomes not only feasible but also desired or necessary" (p. 121). Wilson (2008) concentrates on four central elements as a part of the Indigenous Research Paradigm, to include ontology, epistemology, axiology, and methodology (p. 70). He encourages people to think of these four elements in a circle and that they blend from one to the next in a *relational* manner. He describes the ontology and epistemology as based upon "a process of relationships that form a mutual reality," and that "axiology and methodology are based upon maintaining accountability to these relationships" (Wilson, 2008, pp. 70-71).

Furthermore, a key guiding principle to the way I will approach my research is through Wilson's (2008) concept of *relational accountability*, which he describes as "fulfilling a role and obligations in the research relationship – that is, being accountable to your relations" (p. 77). Due to our kinships to one another as Indigenous peoples, as well as our responsibility to one another and our communities, our web of relationships and ideas naturally become hermeneutic. Wilson (2008) emphasizes that "logic needs to become more intuitive as the researcher must look at an entire system of relationships as a whole" and that "any analysis must examine all of the relationships or strings between particular events or knots of data as a whole before it will make any sense" (p. 120). Thus, this idea of collaboratively producing new knowledge *with* one another is at the core of an Indigenous research paradigm. As an Indigenous person, not only do I wholeheartedly agree with Wilson's recommended approach, but it is naturally built into to who

I am. From start to finish, I have sought to establish reciprocal relationships with my participants beyond the typical Westernized research paradigm of a more one-sided relationship. We have laughed and cried together, and even shared personal photos or accomplishments with one another beyond the parameters of the study. Wilson's notion of relational accountability, for me, is my commitment to keeping in touch with each of my participants and encouraging them along their individual journeys, as well as celebrating successes together.

With the coupling of TribalCrit and Indigenous research paradigm, I will be able to analyze my findings in a critical and relational way from an Indigenous perspective. This analysis allows me to center my Indigenous ways of knowing in analyzing Indigenous student perspectives on their experiences in engineering programs the Westernized academy. The privileging of our perspectives will produce a powerful collective outcome. Enhancing my study even further is my use of Archibald's (2008) Indigenous Storywork, which I will explain more in the next section.

Indigenous Storywork

Kovach (2008) asserts that "stories are vessels for passing along teachings, medicines, and practices that can assist members of the collective," and these stories "reveal a set of relations comprising strong social purpose" (p. 95). Storywork was developed by Jo-Ann Archibald of the Sto:lo Nation in her work with Coast Salish and Sto:lo elders, as a way to bridge storytelling as a legitimate methodology in educational contexts. Storywork acknowledges the intense work associated with research, and particularly the listening, sharing, and articulation of our stories (Archibald, 2008; Chow-Garcia, 2016; Tachine, 2015). Storywork is guided by seven principles, which include respect, reciprocity, responsibility, reverence, holism, interrelatedness, and synergy. Archibald (2008) focuses on the Indigenous concept of

holism (see Figure 3.1) in setting the context for Storywork, which encapsulates the interrelatedness between the intellectual, spiritual, emotional, and physical facets of our holistic being. Obtaining harmony and balance is a common goal amongst our communities. Through storytelling, one can achieve balance since "stories have the power to make our hearts, minds, bodies, and spirits work together" (Archibald, 2008, p. 12). In Cherokee, we refer to balance as Utiyvhi. We strive to maintain balance at all times, and when we are not balanced, we may smudge and/or participate in ceremonies to re-center our mind, body and spirit. By following Storywork's seven principles throughout my study, I feel I am able to honor my students' stories and reclaim Indigenous ways of knowing and methodologies that will continue to provide healing for our tribal nations.

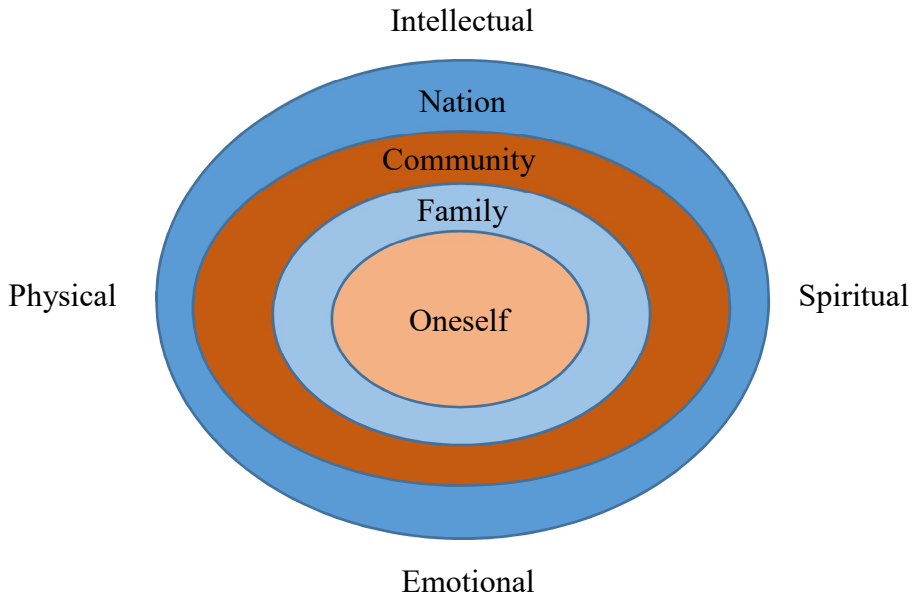

Figure 3.1. Visual representation of the concept of holism (Archibald, 2008, p. 11).

Rationale for Methodological Approach

Indigenous scholar Linda Tuhiwai Smith (2012) asserts that "the past, our stories local and global, the present, our communities, cultures, languages and social practices – all may be spaces of marginalization, but they have also become spaces of resistance and hope" (p. 4). It is within this mindset of fostering continued resistance and hope for our communities that guides my research approach. Consequently, the rationale of this methodological approach is rooted in my desire to recognize the personal educational lived experiences of American Indian students pursuing undergraduate engineering degrees at public four-year institutions in a culturally relevant manner. Why do Natives choose to attend a NNCU? What has contributed to Indigenous student success that can be shared with future generations of Native students? How can this knowledge attract and motivate Native students into engineering pathways? Indigenous Storywork is appropriate for this study since Native students are known to approach post-secondary education from a unique cultural foundation (Benjamin, Chambers, & Reiterman, 1993). As Indigenous researchers, we understand that we operate and work within institutions that were not created to house our epistemologies and ontologies. These same institutions have continuously created barriers of oppression and have silenced our voice as Indigenous scholars (Patel, 2016; Brayboy, 2006; Wright, 1988). Our time has come to reclaim our methodologies and epistemologies as valid ways of approaching research within our own communities.

This study also takes a critical qualitative approach to bring forth structural inequities and the lived experiences surrounding these inequities. TribalCrit builds on CRT's centralized focus on the role of racism, calling out colonization as a systemic inequity that has continued to perpetuate through time in various forms (Brayboy, 2006). Furthermore, TribalCrit offers a conceptual framework to understand how colonization intersects with aspects of our politicized

and racialized identities as Indigenous tribal peoples, as well as providing methods for research and praxis to address relevant issues affecting Native students today. Through the coupling of TribalCrit and Indigenous research paradigm, I challenge the dominant discourse on what student success looks like for Native students in engineering programs. Brayboy (2006) makes clear that his intentions in building TribalCrit was to "center Indigenous ways of knowing and lead to American Indian sovereignty and self-determination" (p. 18). Both paradigms bring tribal values, philosophies and beliefs to the heart of this study, creating a critical and inclusive analysis to understanding Indigenous student experiences within institutions of higher education.

While Indigenous methodologies may seem like a new approach to the realm of Westernized research, we know that our methodologies are "a new way of knowing and being that is so old that it looks new" (Emerson, 2014, p. 58). We, as Indigenous peoples, are so interconnected through this research that it is important to view every participant and idea as an integral piece of the web of connectedness. Through an Indigenous Storywork approach, I position my participants as co-researchers and co-constructers of knowledge through the art of storytelling. In this manner, my findings not only provide insight, they disrupt the dominant deficit narrative around Native student experiences in higher education. Engaging in Indigenous storytelling allows me to critically analyze and make explicit Native student stories of persistence. Given that Native student experiences in engineering programs have not been shared through their own lenses, this study was designed to make their stories visible while disrupting the dominant discourse. This new collective knowledge gained in tandem with my relations will assist NNCUs in providing supportive environments for student success to occur.

Researcher Positionality

An important part of understanding my research and my relation to the phenomenon under study is sharing my positionality. As I shared in the first chapter, my Indigenous identity emerged in my undergraduate years as I immersed myself into Native student organization involvement. While I understand my biracial identity is complex, I also am aware of my white-passing nature. The idea of white-passing is very complex, and I do believe the label acts as a colonial tool that creates a sense of othering within communities of color. However, I also understand the privileges that come with being accepted as a part of the white community, whether I want them or not.

As previously discussed, my undergraduate college years were integral to shaping my identity and my current educational and research pursuits. About three years post-undergraduate, I was fortunate to have a graduate school colleague call me about a new opportunity in my institution's College of Engineering. She served as the director of multicultural engineering programs at the time, and believed in my abilities to serve in this new role, coordinating scholarships and internships for the entire college. Once I obtained the role, my office became housed in the multicultural engineering programs office, and I worked closely with the program's staff and students, eventually leading to my appointment as creator and director of new high school summer camps aimed at outreaching to and recruiting female students of color. At this point, I discovered my true passion for recruiting students of color to engineering pathways.

Due to my connection with our students of color, I supported each of our multicultural engineering organizations, to include AISES, National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), and the Society of Asian Scientists and

Engineers (SASE). Additionally, since women are underrepresented in engineering programs and pathways, the Society of Women Engineers (SWE) was also considered a multicultural engineering organization. I served as SWE advisor just a year into working at the College of Engineering, and then the following year, I was asked to serve as AISES advisor. For the sake of this study, I focus on my experiences as AISES advisor, as I felt a deep connection with my Native students due to our shared Indigenous identities. AISES was my family, and I know the students felt the same connection.

As AISES advisor for eight years, I was personally invested in my Native students and their success. While we had both science and engineering students involved, we had an overrepresentation of engineering students since our AISES chapter was housed in our College of Engineering. The longer I worked in engineering, the more I began to internally question why I had not chosen to pursue engineering as a career path, especially since I was did well in math and science classes. However, I do know that my lack of knowledge of the career path, and my misunderstanding that it was more of a "men's career" ultimately led to my pursuing other avenues. From my years as an engineering staff member, we were always focusing on disspelling myths about an engineering education with K-12 groups, and I became passionate about encouraging students to pursue a career path full of opportunities that I had not been afforded. I wanted our women and students of color to know that they have the capabilities to pursue this major and understand the broad array of satisfying careers they could have, innovating change across industries, and offering social mobility to their families and communities. Like many of my participants, I believe in forging and sustaining relationships for the benefit of our Indigenous communities. Consequently, understanding the stories of Native student experiences in engineering programs emerged as not only an area of interest and curiosity for me, but as a

necessary avenue to improving our representation in engineering fields for the betterment of our country and most importantly, our tribal nations' sovereignty.

Data Collection

In order to fully understand the lived experiences of undergraduate Indigenous student experiences, I conducted individual Skype conversations with seven Indigenous students currently enrolled as an engineering major at public four-year, non-Native institutions, or those who had graduated from an undergraduate program within the last five years. The number *seven* is significant in the Cherokee culture. Our symbol, the Cherokee seven-pointed star, represents our seven clans, the seven important things on earth, and the seven directions. The seven directions include the four cardinal directions, and three additional directions exist: Up (the Upper World), down (the Lower World), and center (where we live and where we always are). Additionally, the number seven represents a level of purity and sacredness that is difficult to attain. Seven became the final number of participants in my study, as I reached a point of *saturation* in my findings (Jones et al., 2014, p. 71). Furthermore, I will now discuss how I conducted my research through explaining my conversational protocol and format, how I built trust with my participants, and sampling efforts and other additional data collection methods utilized.

Conversations

I am intentional in referring to my interviews as *conversations*, in that I see distinct differences in the two. Interviews are a more formal, Westernized method of use in research that typically involves the researcher taking information for their own gain. In seeking to decolonize and Indigenize my research, language is vital. Consequently, I felt the word *conversations* more fully embodied the less structured way of communicating with my relations in this study. I also

view the conversational method as a means to co-construct knowledge collectively and for communal gain. The conversational method aligns well with generating rich descriptions of everyday life experiences (Jones et al., 2014) and intentionally incorporates Indigenous notions of relationality, reciprocity and respect (Wilson, 2008) in sharing with one another. Archibald (2008) attests to this more informal style by sharing that "research as *conversation* is characterized as an open-ended interview with opportunity for both sides to engage in talk rather than only one party doing most of the talking" (p. 47). The students and I were able to discuss how their lived experiences have shaped their educational experience and viewpoint of the institution, as well as the successes and challenges they have each had along their journeys. Consequently, conversations was the way I communicated the process to potential participants, and I followed these more informal guidelines throughout the process.

Conversation Format

Though in-person conversations would have been preferred, distance and travel constraints provided barriers to this method. Consequently, Skype provided an adequate video platform to simulate in-person conversations. Each of my participants were very open to Skype conversations, though most had not utilized Skype previously. Prior to the conversations, participants were asked to sign an Informal Consent Form (Appendix B), and then were given a copy of the form for their record. When we first emerged on to the online video conferencing platform, I started with my introduction of myself, my tribal and family connections, and then another general overview of my study. Furthermore, I felt it was important to express my positionality to the study and shared my story of how I came to be passionate about connecting Native students to engineering programs. Fast and Kovach (2019) emphasize the importance of vulnerability in sharing our own stories in Indigenous research as "honorable" and that "the

beauty of this act is that it gives pause as the researcher and invites a shared story to come through" (p. 26).

The seven one-on-one conversations lasted anywhere from 40-90 minutes in length. After my introduction, I asked participants to introduce themselves in their own way and provide information on their tribal and family backgrounds to understand their upbringing and perspective, and then move chronologically through their childhood through their most recent experiences. The conversations were then guided by a broad set of open-ended questions (Appendix C), and participants were asked to describe their experiences bridging their pathway into their engineering programs and experiences. Consequently, the open-ended conversational questions allowed for flexibility for storytelling, and further follow-up questions that dove into the unique experiences the students shared with me. Due to the history of colonization and "research *on* American Indians," rather than to benefit our communities, I wanted to ensure that the students knew my purpose and felt my authenticity with the more informal conversational approach (Smith, 2012).

The participants were all grateful to have a platform to share their experiences and expressed their appreciation for my conducting this important study. I connected with each participant beyond a typical Westernized approach, with a few of the participants sharing family photos with me after our conversations, while others shared news of publications being accepted at major conferences. I left each of the conversations feeling reenergized and encouraged for this beautiful work we were weaving collectively.

Building Trust

In developing trust and rapport, cultural sensitivity is essential when working with minoritized groups, especially populations as diverse as Indigenous groups. Care is crucial when

working with our Native students who will undoubtedly have various levels of connection to their cultural traditions and tribal identities. Just as many researchers have argued, I believe that qualitative methods are ideal in working with our people and communities so that we may describe our experiences and perceptions of our higher education challenges and successes through our own lenses (Brown & Robinson-Kurpius, 1997; Jackson & Smith, 2001; McWhirter, 1997).

Additionally important to building trust and rapport among Indigenous people is our ability laugh as a way of healing. Archibald (2008) discusses the use of humor in providing comfort to participants stating that the lack of humor could call for questioning of legitimacy or validity of the data. Consequently, in all of my Skype conversations with my participants, we had many moments of laughter as we shared with one another. Since a couple of the participants and I already had established relationships, we had plenty of jokes to share. Even for those who I was just getting to know, we shared laughter and humor only as us Natives would understand. Even in times of sharing serious experiences, we were able to laugh to provide encouragement and healing. Archibald supports how humor plays into Native conversations by stating that, "humour has a healing aspect for both the storyteller and listener in that those who have lived through very difficult circumstances achieved some emotional or spiritual healing and resilience" (p. 68). Furthermore, humor is another example of how I stayed true to building trust with my relations in this study.

Sampling

Participants were selected using a combination of purposeful sampling methods, to include random, criterion, and snowball sampling, which allowed me to gather those who will provide information rich data (Yin, 2016). Snowball sampling aligned well with Indigenous Storywork

and its focus on relationships and reciprocity. Since Native engineering students are small in number across the nation, those at the junior level or beyond are even more dismal. Consequently, students know who the few other Native students are and were willing to share information about my study to their peers. One of my local participants even invited me to come speak at their collegiate AISES chapter meeting after our conversational experience.

Given my professional affiliation and my involvement in AISES over the last several years, I obtained permission from AISES headquarters to make a general call for participants via e-mail (Appendix A) from each of the AISES regional student representatives. Additionally, I created a recruitment flyer (Appendix E) that was shared through e-mails to colleagues and social media platforms such as Facebook, Twitter, and Instagram. The flyer was then sent to many diversity professionals in engineering departments at an array of four-year public institutions across the nation, a few of whom I knew personally through networks in AISES, the Society for the Advancement of Chicanos and Native Americans in Science(SACNAS) and the National Association for Multicultural Engineering Program Advocates (NAMEPA). Additionally, I sent my recruitment e-mail to many staff who worked with on-campus Native cultural centers. To align with Storywork protocol, I purposefully utilized my connections to ensure that relationality and reciprocity were threaded throughout my entire recruitment approach. Because I have personal relationships with many Native professionals who serve in these roles at these institutions, they were able to attest to my character and authenticity through specialized messages on my behalf to particular students. This approach was the most fruitful, and many students began reaching out to me to participate. Participants were then selected based on criterion sampling where: 1) Participants must self-identify as Indigenous, Native American, Alaska Native or Native Hawaiian; and 2) participants must be classified as a junior or senior in

their respective undergraduate engineering programs, or be a graduate within the last five years from a non-Native, four-year public institution. To fully understand the success stories of those who have persisted in engineering, I felt it was best to reach out to those who had at least made it into their major coursework, which begins their junior year. As a result, my pool included Indigenous students in engineering majors who have persisted successfully in their respective programs.

To finalize and broaden the participant pool, snowball-sampling methods were also used to have a strong representation from various institutions around the nation. Wertz (2005) supports this method of selection by explaining that "judgment of whose experience most fully and authentically manifests or makes accessible what the researcher is interested in" (p. 171). Purposeful sampling allowed me to be intentional in my selection from my pool of candidates who might offer differing viewpoints based on their varying upbringings – traditional or nontraditional experiences with their Indigenous culture prior to attending the institution. Furthermore, I made every effort to ensure a fair representation of men and women, since women are still underrepresented in engineering fields.

Additional Forms of Data

In addition to the conversations, I composed personal reflections, or researcher memos, that allowed me to process and record my initial thoughts throughout the process (Yin, 2016). Archibald (2008) discusses how many of the Elders she engaged with kept saying it was important to learn how to listen with all of our senses, including bridging our heart and mind together. She emphasizes the importance of "linking how we feel to what we know" as an important pedagogy (Archibald, 2008, p. 76). In order for me to express what I felt upon listening and re-listening to the Skype conversations, I took time to write up my own reflections,

including my interactions and connections with each of the participants, observations of their personality traits and body language, and any other thoughts that were important to the study. Not only was this memo process therapeutic, but it also provided vivid reminders of our conversations that transcends beyond the spoken word shared.

Additionally, the participants were asked to complete reflective journal entries (Appendix D) to give them extra time to incorporate any other thoughts that they wish they would have shared. They were able to record any feelings during the process that would aid in my understanding of their experience that I may have missed or otherwise misinterpreted. The participants could think about the conversation experience and questions further and express themselves freely. Participants were provided with instructions and a pseudonym of their choosing on it immediately following the conversation with a deadline of a week later to return them to me via e-mail. They were encouraged to type their reflections and send them electronically to me a week later. While these reflective journals were not mandatory, only three of the students provided me with additional comments. Consequently, the findings represent data collected from the one-on-one conversations and reflective journals.

Reciprocity

In following with Indigenous ways of engaging with one another, reciprocity is a key component. Kovach (2009) describes the importance of reciprocity in Indigenous relationships, and that this is all directly tied to relationships and trustworthiness of the researcher. Ensuring that stories are understood accurately, responsibly and respectfully is of vital importance to our Indigenous communities; therefore, we must request approval of the research and how it is conveyed prior to publishing. Not only does this enhance the data's trustworthiness and validity, but it is a responsibility that maintains relationships with our people and gives back in a more

meaningful way. By giving the participants' transcriptions of the conversations afterwards, we were able to co-create new knowledge together in a respectful and honorable manner. Even my participants' motivations for participating were forged from seeing the benefit sharing their stories would have for future Native engineering students. They each understood the reciprocal benefits and wanted to share in order to give back to future generations. Archibald (2008) describes reciprocity in Indigenous cultures as "one is taught to pass on what she/he has learned to those who are interested" as "this passing of knowledge is a way of perpetuating it" (p. 126). After participants' provided their feedback, I made any necessary adjustments to my interpretations of their experiences to ensure reciprocity and validity of my study.

Data Analysis

In moving to the analysis process, the Skype conversations were recorded, transcribed, and then analyzed in a series of steps by the researcher. As mentioned in the previous section, field notes were recorded immediately following the conversations to capture initial impressions and nonverbal components (Yin, 2016). Then, I reviewed the transcripts allowing me to gain an understanding of the interconnectedness of the participants in relation to their experiences, and to each other (Archibald, 2008). From there, I re-read the transcriptions to distinguish meaning units to begin the thematic analysis process.

Interconnectedness in the Students' Stories

After reading and re-reading of the transcriptions and then pulling overarching themes from the texts, I went through a process of finding the interconnected threads throughout the seven engineering students' stories. As I read through the first couple of times, I highlighted various general themes that emerged, as well as key phrases in the participants' own words, that may serve as powerful theme expressions. As a visual learner, this process worked well for me to

begin to make sense of the students' stories. Throughout this process, as particular stories emerged, I made note of these in the right-hand margins of the transcripts with additional thoughts attached. I completed this process for each of the seven transcripts while simultaneously making memo notes of all of the initial codes for each participant.

In the second phase, I looked for linkages between the initial themes. I used color-coded highlighters to synthesize and sort through the themes. This involved eliminating a few initial codes that only occurred for one of the participants, and not the others. I then categorized each by pre-collegiate and collegiate experiences to parse out the early childhood experiences from the experiences during their undergraduate careers. This required by sitting with students' stories for several weeks, or making adjustments as needed. From this point, I compiled the two lists of pre-collegiate and collegiate codes on one document, and began to utilize my own Cherokee tribal epistemology to make relational connections between the codes.

Utilizing a different color highlighter for each common theme, I was able to establish connections between the students' stories. Having each individual under a separate box, I began using an orange highlighter to symbolize early connections to engineering concepts, or green highlighter for parental or teacher influences. By laying the data out in this color-coded fashion (see Figure 3.1), I was able to assess the data side-by-side, allowing me to truly *see* and determine the connected themes I would use as a part of this study. Viewing the data visually in this way allowed for me to make the conceptual connections of experiences, and understand how the participants' experiences were similar in multiple ways (see Figures 3.2 and 3.3). Ultimately, this process led to my creating a model that I felt encompassed a relational cycle of experiences among the seven participants. The model emerged as the Utiyvhi (balance) in Engineering model (see Figure 3.4) from combining important Cherokee knowledge and symbolism to create a

continuous circular flow of experiences from the early childhood years to their collegiate years, and then continuing on in the cycle of life in all of these experiences influencing future generations of Indigenous students considering engineering pathways.

As I sketched up what my model looked like, I began to see a larger, holistic theme I felt encompassed the entirety of my participants' experiences. The broader theme captured all of the smaller themes that emerged into one major model that encapsulated the seven Indigenous engineering students' stories. The four major themes with subthemes unified to create what I

Figure 3.2 Visual Concept Wall of Participants

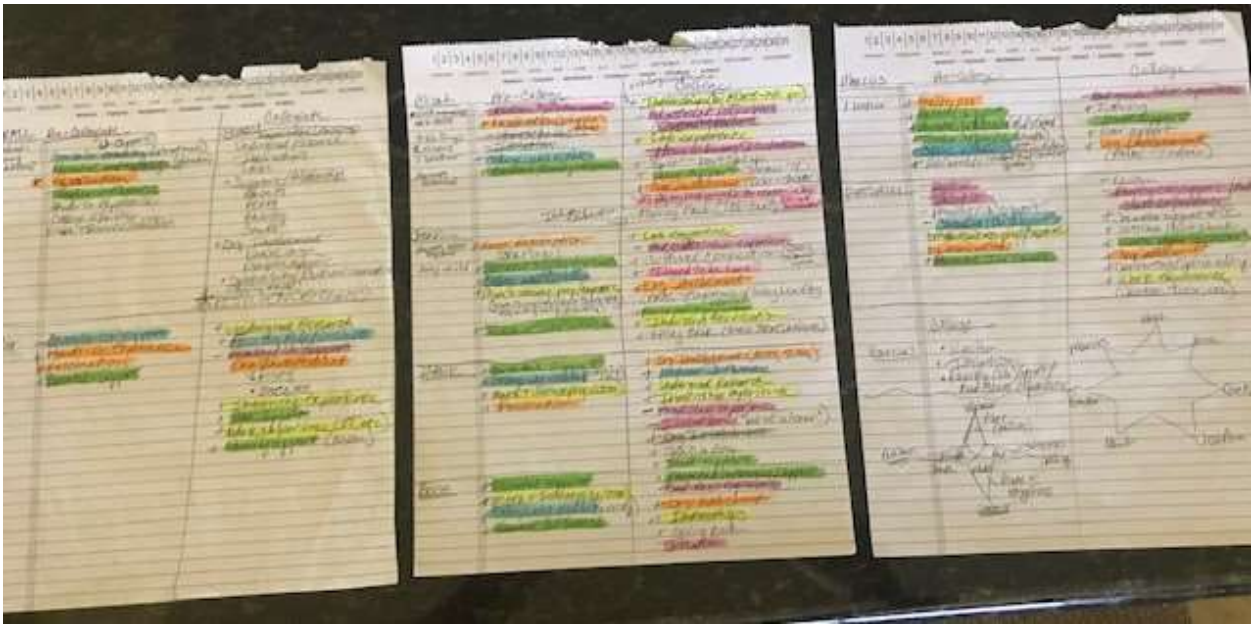

Figure 3.2. Visual Concept Wall of participants with focused themes. Each Indigenous engineering student had corresponding initial themes highlighted in various colors.

is a model of persistence and success that institutions must provide for Indigenous students pursuing engineering pathways at NNCUs: 1) establish an early connection to STEM; 2) understand how survivance is utilized in overcoming challenges; 3) identify support networks

and build on-campus community; and 4) connect students to experiential learning to assist in their finding belonging in the engineering profession. I designated the name "Utiyvhi in Engineering model" to signify this circular and relational pathway to navigating their way to attaining degrees in engineering at their four-year, public non-Native institutions. I will discuss the Utiyvhi in Engineering model in more detail in chapter five.

Figure 3.3 Second Phase of Connecting Themes Visual

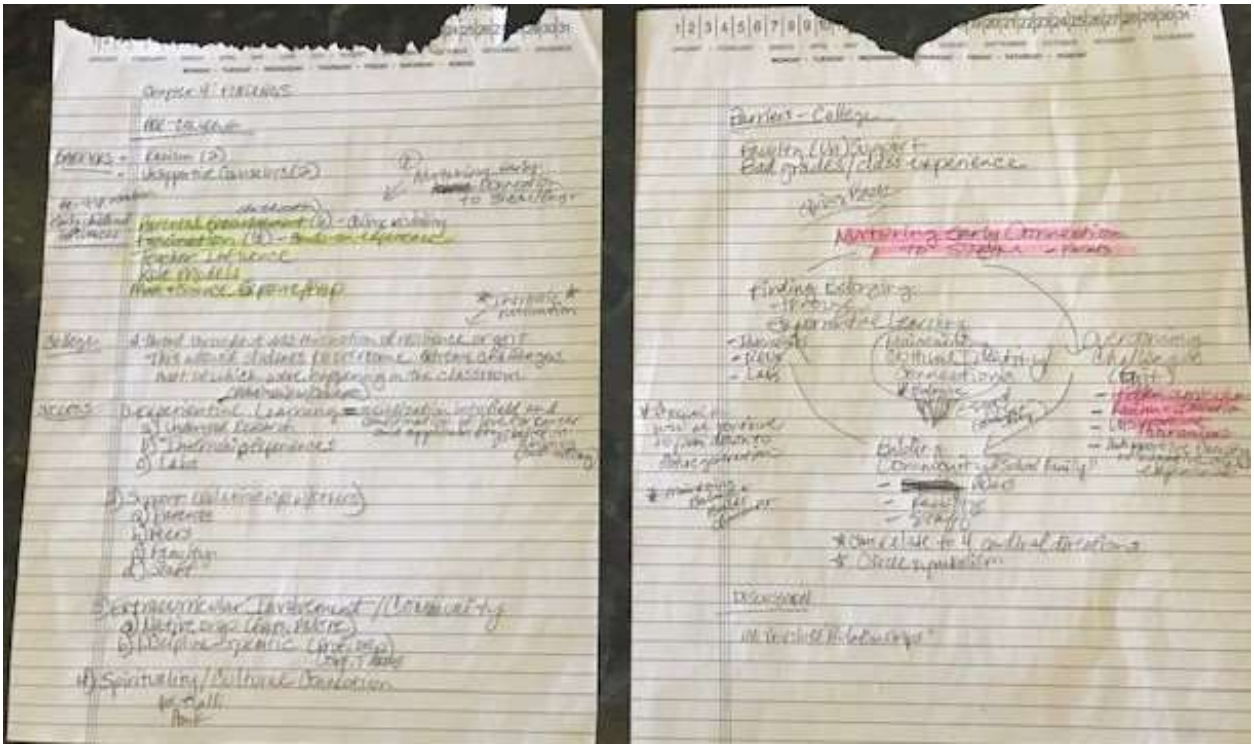

Figure 3.3. Second phase of connecting themes visual. The four major themes that emerged are at each of the directional points along the circle. Though the themes were altered based on participant language, this graphic portrays the original themes that include: Nurturing Early Connection to STEM, Overcoming Challenges, Building Community, and Finding Belonging through Experiential Learning.

Figure 3.4 Utiyvhi (Balance) in Engineering model

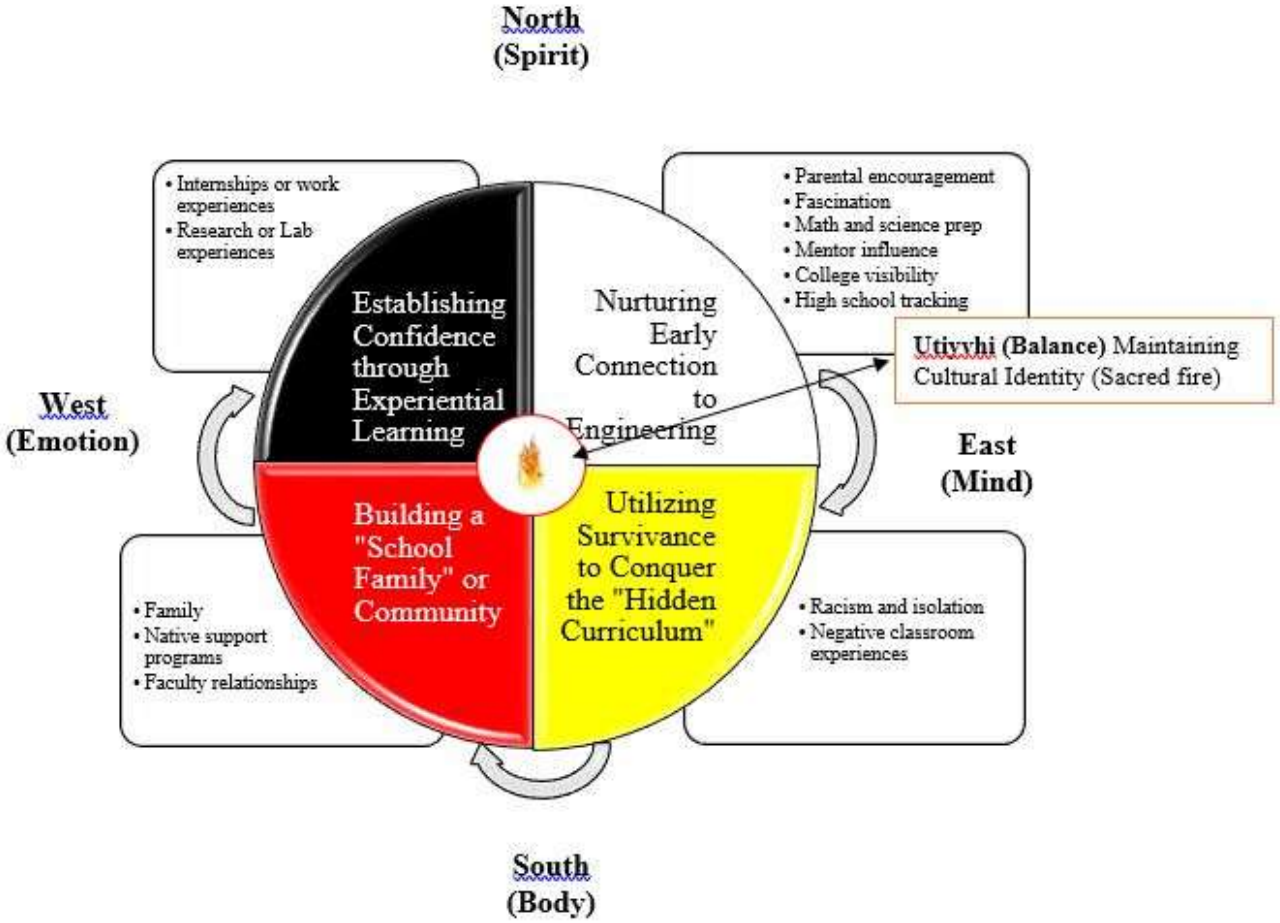

Figure 3.4. Utiyvhi in Engineering model. Based on the Cherokee medicine wheel symbolism to emphasize the power of an individual's path toward personal growth and realization, the four elements move in a relational and cyclical manner that leads to Indigenous student persistence in engineering programs at NNCUs.

Limitations

This study was designed to focus on a small sample of Indigenous students or recent graduates from undergraduate engineering programs at mainstream institutions. Given the almost nonexistent research on Indigenous students in engineering, this study was created to fill that

tremendous gap and offer a culturally appropriate methodological stance. As the primary purpose of this study is to substantially increase the number of Indigenous engineering graduates, these stories of seven Indigenous engineering students bears much meaning and direction to the future efforts of increasing Indigenous participation in engineering fields.

With 574 federally recognized tribes in the United States, the Native American population is spread broadly throughout the nation with 78% of Natives living outside of tribal areas. In my efforts to gather a diverse range of Indigenous participants of various gender identities, tribal representation, and including a broad range of representation from undergraduate engineering major programs and four-year non-Native institutions, it took six months and repetitive and persistent efforts to reach out to various four-year, public institutions, and responses were slow to trickle in. Additionally, I noticed that the language I used in my materials was very important, as Indigenous students may identify with different terms, such as Indigenous, Native American, American Indian, Alaska Native, and/or Native Hawaiian. Furthermore, these differences are further complicated by one or more tribal affiliations, multiple racial identities, upbringings on tribal territories or reservations while others grew up in urban and rural communities, and varying degrees of cultural connection and gender identities. Some are now in graduate school, while some are working in industry. Therefore, the small number of participants may limit generalizability. However, this study offers a starting step toward understanding how Indigenous people navigate the engineering pipeline successfully.

Summary

This dissertation intends to address the gap and disrupt the current deficit discourse that erases stories of Indigenous peoples persisting in engineering. The “American Indian asterisk” is more ubiquitous in STEM fields where we are left out of many studies or deemed insignificant.

This study seeks to illuminate the stories of Indigenous engineering students through the employment of Indigenous conceptual frameworks, research methods, throughout my data collection, analysis, and in the co-construction of knowledge. I chose to share the lived experiences of seven Indigenous engineering student experiences by conducting semi-structured *conversations* with the option of completing a post-reflective journal. As an understudied group in both Native American higher education and STEM student of color literature, I applied Indigenous research paradigm and Tribal Critical Race theory to ground this inquiry and to understand the ways in which Indigenous engineering students make meaning of their experiences in engineering.

Chapter Nvgi (Four): Stories of Engineering Students

The research question that continues to guide my study is what are the experiences of Indigenous undergraduate students persisting in engineering programs at four-year, public, non-Native institutions? My four sub-questions included the following:

1. What were the students' pre-collegiate pathways to pursuing an engineering degree?
2. What is motivating and supporting Indigenous students to persist in engineering majors at four-year, public non-Native institutions?
3. How can the lived experiences of Indigenous students guide student affairs professionals in creating a more supportive community for Indigenous students in engineering programs?
4. How can we work to promote engineering careers for the betterment of tribal communities and sovereignty?

In this chapter, I begin with an important introduction to the seven Indigenous engineering students, who honored me with their stories of strength and resilience. I weave my students' stories into this powerful collective piece, and privilege Indigenous Storywork principles of respect, responsibility, reverence, reciprocity, holism, interrelatedness and synergy (Archibald, 2008). Furthermore, I present an overview of the major obstacles that these students overcame along their journeys, followed by major themes that emerged from the seven Indigenous engineering students' vulnerability and strength in sharing their stories, so that those coming behind them may have a guide to success in these fields. I know our ancestors are very proud of them.

Indigenous Engineering Students

Each of the Indigenous students share their truth in the form of stories along their pathway to studying various engineering degrees at four-year, public non-Native institutions. While immersed in this heart work, I felt immensely connected to each of the students because I could relate to some of their experiences, struggles and their resiliency in working toward achieving their collegiate goals. Their stories empowered and inspired me, and reminded me why this work is so important. Many of the students expressed their gratefulness for being asked to share their stories in engineering undergraduate programs, and having this platform to do so. Their stories lit a fire within me to keep forging ahead with this collective dissertation work as a way to reciprocate this new knowledge back to my tribal and campus communities.

Their stories begin with early childhood memories of family and educational experiences, and then move through their narratives of their engineering journeys. Their stories continue into adolescence and early adulthood years of preparing for their respective higher education journeys to the current day. Our discussions moved in a circular pattern through their varied experiences with the selection of an institution to settling on a major pathway, and through their experiences in their respective programs. For some, this journey continued through post-graduation phases of graduate school or the professional work environment. This circular pattern is indicative of our interconnected ways of being as Indigenous peoples to each other, the land, the earth, and the cosmos. Wilson (2008) discusses the symbolism of a circle:

> For me, putting ideas in a circle or wheel indicates that they are interrelated and that each blends to the next. It also implies that the ideas flow from one to the next in a cyclical fashion. A change in one affects the others, which in turn effects new change in the

> original. All parts of the circle are equal; no part can claim superiority over, or even exist without, the rest of the circle. (p. 70)

The circle is a symbol we see often in Indigenous culture, and often in Cherokee culture. Ceremonies, pow wows, and talking circles all involve circular patterns in how we move about the grounds, or in the flow of how we talk story with one another in a relational and respectful manner in an enclosed circle. On a more spiritual level, the circle symbolizes interaction among all living beings on Mother Earth. Circles are walked in a clockwise direction (the direction of the Sun). It can also show the stages in a person's life or spiritual development, indicating that life doesn't end at the completion. Walking the life journey causes rebirth or renewal. Archibald (2008) emphasizes the common goal each Indigenous group has when it relates to the circle being the attainment of "a mutual balance and harmony among animals, people, elements of nature, and the Spirit World" (p. 11).

My intent in sharing these seven engineering students' stories is to exemplify how they have obtained balance to persist in their respective engineering programs at NNCUs. Each student shared stories that were inextricably bound to one another creating a cohesive, powerful collective voice. Consequently, I hope to give these stories the space and justice they each deserve as I weave their stories together in presenting my findings and analysis.

Selection of Pseudonyms

As Poolaw (2017) noted in his dissertation work with Indigenous men in graduate programs, in following cultural protocol, I would usually be inclined to share each of my storytellers' traditional introductions to include their tribal nations, family names, clans, bands, and dance grounds, but I must be a good relative and protect and respect their anonymity.

Consequently, I offered each of my students a chance to either use their real names, or to choose a pseudonym that was meaningful to them. Each of the students chose a pseudonym that was a nickname, relative's name, or carried symbolic and cultural meaning. Four of the seven students were comfortable with using their real names. Patel (2015) emphasizes that not masking names in research can provide a platform for visibility as this can counter "an anonymizing of identity to deny personhood" (p. 65). I wanted the students to feel empowered to be recognized for their stories and knowledge shared if they so chose. However, I also wanted to honor and respect requests for anonymity as many stories of hardship are not ones they have shared with others or feel comfortable doing so. Additionally, I went one step further to anonymize all cities, institutions, and tribal names by utilizing pseudonyms.

Organization of Story

I am beyond humbled and honored to share these powerful Indigenous student stories with you. Like Chow-Garcia (2016) noted in her dissertation, I also felt it was important to begin with a short description of the nature of our relationship, in honoring an Indigenous approach to this study. This allows the reader to understand how we connected, and get a glimpse into our interactions throughout this study. Furthermore, I will now introduce the seven Indigenous engineering students by providing a brief biographical story of each one to include their tribal region and family information, an overview of the pre-collegiate pathways, a brief overview of their collegiate journeys in their respective engineering programs, and some concluding pieces of advice for future generations of Native students considering engineering pathways. I have ordered their stories by the point in their life paths, starting with those who have already graduated, and moving through the eldest of those still in undergraduate programs to the youngest. In assisting with my visualization of their journeys, I envisioned the Cherokee seven-

pointed star (Figure 4.1), and that is what I used as my guiding point for moving in a circle clockwise, starting with Quetzalli and concluding with Marcus, to move through each of the engineering students' pathways to engineering.

Figure 4.1 Cherokee Seven-Pointed Star: Pathways of Indigenous Engineering Students

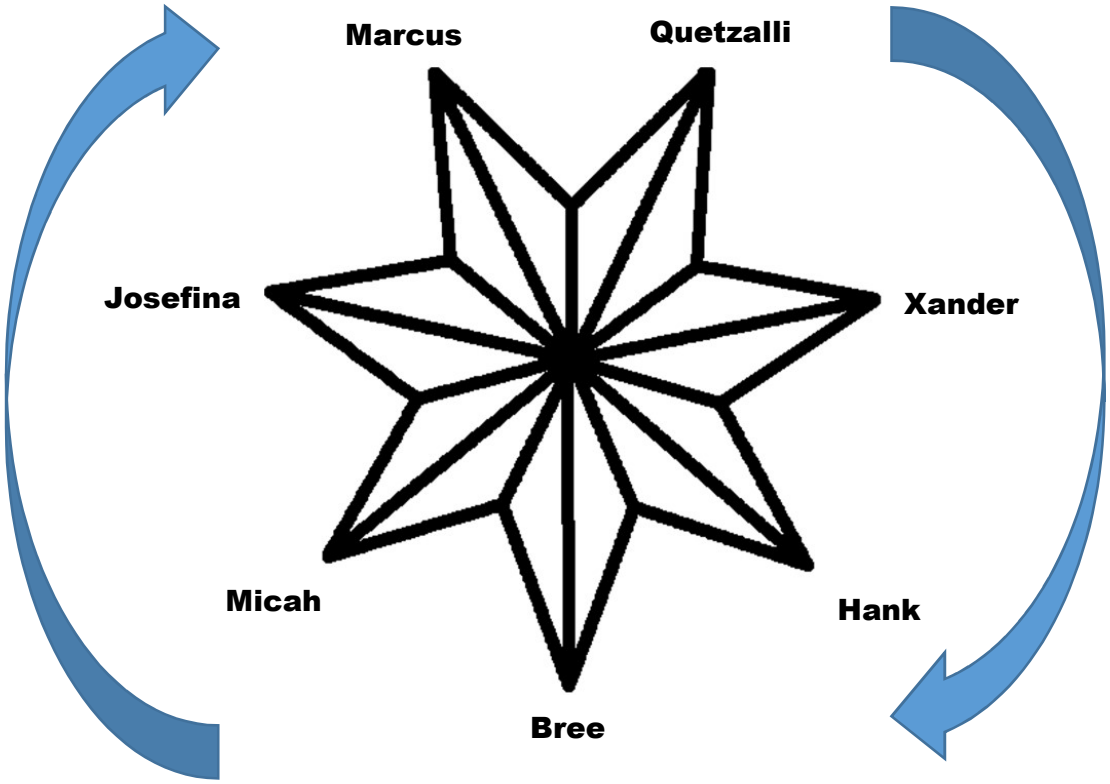

Figure 4.1. Cherokee seven-pointed star: Pathways of Indigenous engineering students. The Cherokee star represents the interconnectedness of each of the seven students, and the flow of their pathways in order of where they are at on their collegiate journeys.

Engineering Student #1: Quetzalli

I first engaged with Quetzalli as she responded to one of my e-mails I had sent to SACNAS chapters all over the nation. Once we scheduled our Skype call, Quetzalli was so calm and easygoing, even as she shared extremely vulnerable stories with me about her tumultuous

home life as a child. I became engulfed in her life stories and am truly inspired by the wisdom she has gained from it all. Her strength and resilience are unwavering, as her culture and her two children really motivate her to keep persisting.

She shared many stories of racism with me, both during her undergraduate and graduate experience. She was often referred to as a "wetback" or "illegal immigrant," and told to "go back to Mexico." Unfortunately, her children experienced similar treatment when she lived on the West Coast while she was attending her undergraduate institution. Upon graduation and when considering her graduate school choice, she says that she had to consider the local community and environment. She reached out to other graduate students of color at the institutions she was considering to find out what their day-to-day experiences were in the community. She finally made a decision to attend an institution in the Pacific Northwest due to an advisor connection.

However, when Quetzalli described her undergraduate living situation, she dealt with racist neighbors who she said "would pound on the wall and say things like, 'shut up you f**king Mexicans,' or 'get out of here and go back to where you came from.'" She had to cover her daughter's ears, and tried to speak to the apartment manager about it. All he offered was mediation, and then when she scheduled it, the man who was yelling the racist comments never showed up, but sent his wife to apologize instead. Quetzalli said that the one meeting was all that was ever done to amend the situation. This is a snapshot into what Quetzalli describes as encounters her family had to endure at least once a week. Due to affordability, she had to stay in those apartments close to campus.

I personally felt an immense bond with Quetzalli, and plan to keep in touch with her as she completes both her master's and doctoral programs at her current institution. Immediately following our Skype conversation, Quetzalli shared a couple of family photos with me of her and

her two children in their traditional regalia. I was really touched by this gesture and the opportunity she provided for me to get a glimpse into her life, and see her two beautiful children, with her oldest already a teenager. She has so much wisdom to share with future Indigenous students, and I felt very inspired by now knowing her, and her sharing her story with me so that I may share here to influence future generations of Indigenous engineering students. Now I will share her story.

Quetzalli's Story. Quetzalli is a current graduate student at a university in the Pacific Northwest. She is a Chicana and Indigenous woman from a tribal people with its origins in northern Mexico. However, she was raised on the West Coast in an urban community. She chose her pseudonym with thoughtfulness, and explained to me that Quetzalli comes from Quetzalcoatl, which means "feathered serpent," or "plumed serpent." The serpent represents strength and the ability to have an abundance of inner energy to go through battles and achieve greatness. Quetzalli explained that the feathers are a strong link with nature and are sacred in her ceremonies and her battle uniforms. She added that she chose the name as she felt it represented her life experiences well.

Quetzalli grew up hearing her tribal language spoken at home, but she was never taught the language. She further explains her story:

> It was spoken – we speak [our language]. Well, I don't speak [our language]. My parents… except that I remember my father tried to teach me [our language] and my mother is saying not to because we're in United States I will not be needing that. That's not going to help me. What I needed to learn was how to speak English and Spanish, but mostly English. So I don't… I never learned the language very well to communicate both to even understand what when the elders speak, my grandparents and other people. No,

> they didn't go into any traditions. It's funny because [the West coast city] I grew up in – the population of [my tribal people] grew a lot and they started bringing the traditions from Oaxaca over to the nearby churches. And it was interesting to see how so many of our community members pushed back on that because they were like, we're not Oaxaca, we are in the United States.

Quetzalli additionally shared that one ceremony she and her family have always celebrated is the Day of the Dead. Her grandfather shared many stories that made her realize why traditions were not continued in the United States. She learned how the history of colonialism shaped how her culture was "hidden under the Catholic religion." He told her that her own mother was beaten with a ruler in school if she spoke their tribal language, as she was taught to speak only Spanish.

Quetzalli describes her upbringing in a city on the West coast 14 blocks away from the beach. She said it was a predominantly white community where she did not see many people who looked like her, but that she was grateful for the schools she was able to attend. She describes her schooling experience here:

> I think I was fortunate in growing up there because they have a really good school district, really good education system. And I think that's what really helped me where I am right now. I had the right resources, I had the right instructors, teachers; I had the right support. I was in a low student to teacher ratio classrooms. It's different than what I see right now in underserved communities where there's a lot of students for one teacher where there's lack of materials for science. I didn't know that existed because I had everything. I had music, I had art; I was in marching band. I had free afterschool programs. And for me to find out when I was at [my undergraduate institution] that not all students have what I had, was really shocking to me. So I was fortunate in growing up

> in… I don't want to say upscale, but a decent community – one that provided a lot of these activities for my education.

As a first-generation and non-traditional student, Quetzalli attended a large public institution on the West Coast during her undergraduate years studying civil engineering, and is now a structural engineering graduate student at a four-year public institution in the Pacific Northwest, where she hopes to complete both her master's and eventually her Ph.D. Her journey has been one full of hardships and conflicts against her family's cultural expectations of a woman's place in the kitchen and attending to household and caretaking duties. As the oldest sibling and only woman in her family, Quetzalli found that school was her "escape" from her negative home environment – one where she was told she would only go to elementary school and then "it was off to the kitchen." Consequently, her relationship with her mother was stifled by her love for her books and she would often do her homework in the bathroom while everyone was sleeping. Her home life also included alcohol abuse and domestic violence, and she was raped at the age of 11. She describes this moment as one that "ruined me as a woman." Additionally, Quetzalli shared that she "learned to love school because school was the best place to be at that moment as opposed to being at home." Once her father left, she said her mother struggled, which made their relationship stressed. She describes her home life:

> I struggled a lot with my mom. I didn't have a good relationship at the beginning, and I really loved my books. And she didn't like that. She said that I was a woman and I had to help her with taking care of the kids and helping in the kitchen and that my homework comes last. And I spent a lot of time sometimes doing my homework in the bathroom because everyone was sleeping and I didn't like to… I was a good student. I had good grades, but I worked really hard for them. I was looking for an escape, I guess. I

> remember I had won a scholarship to go study abroad as an international student and all I needed was her permission and a passport, and she said no. And I felt really awful because I had taken four years already of French, and I was doing really well. That's when she said if you want to travel we're going to Oaxaca. And I was like 15, and I was like that's not really the same, but okay. And we struggled a lot with respect to my academics. She wanted me to get a job and to help financially at home. I wanted to strive and I wanted to move forward. I didn't know where because I didn't have the right guidance. But I knew I didn't want to stay at my first job, which was at Bank of America. That was my first job. I was 14, 15 in ROP program and she was so excited. She's like, my daughter works at a bank. But I was miserable. I did not like to dress up in skirts and nylons and heels. That was just not me. I think I have always known I wanted to be in this field of engineering. I just didn't know what it was called… because my father before he left would take me to his work and he worked in construction. And so, I was always exposed to wood frames. I was always exposed to the tools. I always put out his tool belt on and play around with it. He didn't like it as well. He did not like it. I remember him slapping me in the face. [laugh] Because he said that wasn't my job as a woman. My job was to learn how to make tortillas and be in the kitchen.

Despite all of these tremendous hardships at home, Quetzalli performed well in her K-12 school experience, and then became a mom at the age of 17. The birth of her daughter granted her independence from her family where she "didn't rely on [her] parents' permission for the financial aid process." Thus, she enrolled at a local community college contrary to her family's wishes. Upon completing her associate's degree, she then moved away from home to attend a

four-year, public institution on the West Coast. Only one of her younger siblings helped her move because “nobody leaves the family.”

Her father and grandfather were huge influences on her career trajectory. Her father worked in construction and brought her around building sites and tools as a young child, and her grandfather made adobe structures in Mexico, and would tell her stories of how he was taught to build houses from natural resources. Her high school counselor gave her an aptitude test to give her career guidance, and the result was that she needed to be a “farm worker.” Additionally, her school placed her in remedial math each year, but she advocated for herself to get out of those classes eventually, as she loved math and was good at it. When at her community college, she chose architecture at first, as she thought that was the closest to her experiences with her father and grandfather. However, she quickly learned through coursework and an influential community college counselor that architecture was not the right path for her, especially once she discovered Frank Gehr and how he use fish scale concepts into his buildings. Quetzalli knew then that she “wanted to build the frames and make the buildings strong.” This same counselor encouraged her to pursue engineering and take some physics classes, as he thought she would love them. Once she took her first physics class, she “fell in love with it.”

During her undergraduate experience, Quetzalli sought out jobs on campus, and her first job was through an academic outreach program, where she served as the math tutoring coordinator. While there, she had an influential supervisor who encouraged her to embrace her culture and be proud of who she was, as one of the only people from her tribe represented in this engineering program. She noted that “he really helped me remember where I came from and who I am,” and how to use that to “help my community.” Her supervisor’s encouragement really opened her eyes to questioning why she was one of the few of her tribal people in engineering.

This made her “go back to her roots” and she began dancing, and bringing her kids along. She credits her involvement in her culture to her making it to graduation.

Through working for this academic outreach program on campus, Quetzalli was able to discover that she did want to pursue further education. She describes her experience and its influence:

> I started learning more how the NSF proposals have a broader impact component, an education component included, and has the resources we use. Being as I became that bridge between the PIs in the engineering department and the community and the K-12 teachers, by using those resources and taking them to the community, they learned a lot about NSF proposals and who does these proposals because I didn't know that these resources were available for my community. I didn't even know what what you can do with the Ph.D. And I learned a lot. I worked with the department for three to four years. I worked with the electrical engineering department, the Nano Engineering Department, my department, which is structural. And I realized, oh my goodness, I can do a lot more with a Ph.D. if these guys can do this, I can do a lot more because I know where those resources can go. I know how to help my community. At the same time, I have a foot in the door in the technical field. So that was really what motivated me to come back to the university. I didn't even know that engineering education existed. I didn't know that that was an option, and it helped to be an engineer already. [laughing] It helps to have that background and understanding of the curriculum or exposed to the curriculum and exposed to the pathways, right? To obtain and finish an engineering degree.

Now as a graduate student in the Pacific Northwest, Quetzalli notes the change in environment eventually got to her partner, and she is now going through a divorce after moving

her family to this new place to complete her educational goals of becoming a professor. Through multiple mentors, her work in the academic outreach program, and involvement in an engineering student competition team, Quetzalli persisted. She notes that her grandfather's words of inspiration and staying connected with her culture through ceremony has aided in her motivation to keep going. Additionally, she wanted to be "that person that wasn't there for me," as she notes that she "didn't have anybody that looked like me." Though she began to get involved with AISES, Society of Hispanic Professional Engineers, and the American Society of Civil Engineers, Quetzalli was not able to build community in those organizations. She could not attend many of the meetings because she had to take care of her two kids, but she was able to get what she needed professionally from each of the organizations. However, Quetzalli experienced many more challenges as a nontraditional student in the classroom, having unsupportive faculty who would not work with her when she needed help with homework. Additionally, she told me about an experience with a white woman peer of hers:

> I did have this encounter with this one female – Caucasian female – she wasn't understanding the homework and I had already finished it and she asked me, "Well, can we talk about the homework and work on the homework?" And I'm like, Sure." I went to campus and I told her how I did it and she said, "That doesn't look right." And I said, "Why not?" She's like, "It just doesn't look right. I have never seen anything like this. I think you did it wrong." And I was like, "Okay, well, we'll see. I guess I won't know until we get our homework back." And so, she went and she contacted another student who had taken the course before. And that student took the course last year, the year before, and she said, "Hey, can you help me with the homework? I just want to see if I did it right." This was after she consulted with me. She went with the other student and

> the other student actually gave her the homework from last year. And she looked at it and she said, “Do you want to see it with me?” And I'm like, “Okay.” But I felt really confident about my solution. She kept doubting my solution and so we looked at the homework and it was the exact same process as my answer. She was like, “Oh, it looks like you were right. It looks like she did it the same way you did.” I'm like, “No, I did it the same way she did.” And so she was like, “Oh.” She didn’t apologize. She didn't say anything. She just took the solutions from last year and just left. It felt like, well, I think we're done here. I'm like, well, I guess so, but that felt like crap at the beginning, but then I felt very empowered after because I didn't need a solutions from last year to figure out the solution this year. Right? It's the same problem, but I didn't need that external help or resource. We had to work on another homework again using Matlab programming, and I didn't understand the assignment. I really didn't. And I asked a question about it. This was a different assignment – and she got the paper and she gave it to me and she said, “Here, why don't you learn how to read it…why don’t you learn how to read and read the assignment. Everything's in there.” And I looked at her like, oh my goodness, did you really just tell me to learn how to read? And so those are the little challenges that I encounter now, but I've been through them before that I don't take them personally anymore. It's the norm, I guess. That other white people treat me like this because I'm brown. Maybe my English isn't that well according to them. Maybe I don't know how to express myself and maybe English is my second language, which it is.

Despite these daily occurrences, Quetzalli persisted. She was able to gain confidence from her having the correct solutions that kept her going. Currently, Quetzalli founded a new engineering research organization and currently serves as president, in addition to serving as a

graduate fellow as she completes her master's program, and then moves directly into her doctoral program. She said her mother now fully supports her, and even helped her move to attend graduate school.

Quetzalli values her career path as a future engineering education professor, as she "wants to be there for the person that wasn't there for me." She adds that she wants to "write those grants and those NSF proposals and help [her] community because [she] thinks she has a better understanding of what people like [her] go through." She continues her story:

> I want to be one of those very few Indigenous faculty members in the engineering field, which I would be very interested to know how many are there with the Ph.D. I don't know how to look that information up, but I would like to know how many Indigenous or how many even Latinos or female PhD faculty exists in the nation. And I just want to be proof that it is possible. Maybe it's my ego. I'm just kidding. [laughing] But I think that with education comes a lot of power. And there's a lot of power out there to be able to help our communities, and support our students from underrepresented communities…especially Indigenous and Native Americans that even have different challenges than other underrepresented communities. I think I can do a good job in helping others, even though I need to learn how to help myself. But I think that I can bring a lot of positive change, maybe small change that can contribute to bigger changes.

Her experience helped to shape her perspective on giving back to her community. Furthermore, Quetzalli offered words of advice to future Native engineering students attending non-Native institutions:

> Never stop fighting. Things happen for a reason in life. I feel that the universe has a way to only give us challenges that we can overcome. And to think positive. To continue persisting and to never be afraid to ask for help. I think that's important to learn how to ask for help… and that you can do it. I always tell them if I can do it, I know you can do it. We're building character. We're building strength because I would have never shared my story 10 years ago. I've learned to be strong and to be able to talk more comfortably about my challenges as a child, as a single parent, as a student. Then, I think that all the challenges just make us stronger, and I've learned to be aggressive in my field, which is not "lady-like." [both laughing] And I've also learned to bring in my culture and to appreciate my culture and to be proud of my culture. So I feel that it's just making all the challenges that we encountered to make us stronger.

Engineering Student #2: Xander

Xander was the first student to reach out to me via e-mail and left me a voicemail, as his multicultural engineering program coordinator had forwarded my e-mail on to all of her Native students. Since he is a busy full-time working, nontraditional student, Xander was difficult to schedule with, but after a few phone calls, we eventually scheduled our Skype call for late one evening. I really appreciated Xander's enthusiasm in participating in my study, and he had many valuable life experiences to share.

Xander and I discovered on our call that we graduated high school the same year and were both raised in the Southern Plains, so we could certainly relate on some experiences. He was even familiar with my hometown, as he had been there for one of our annual festivals. Additionally, since he attended colleges in the Southern Plains, we knew some of the same people, to include an influential Native professor. Eventually, he would come visit my campus

for an AISES regional conference a couple months later. Xander even invited me up to give a talk about my research at one of his AISES chapter monthly meetings. Unfortunately, it did not come to fruition due to winter weather preventing my drive to his campus. Xander has since graduated from his institution just this past May. Now I will share his story.

Xander's Story. Xander is an electrical engineering undergraduate student attending a large research university in the Southern Plains. Xander is from two Southern Plains tribes, where he grew up gourd dancing. His mother was a tradition dress, traditional dancer for her tribe. He was raised with his two younger siblings in a major metropolitan community in the Southern Plains. Both of his parents obtained college degrees, so Xander always felt encouraged to attend college. His mother and father met when they were both undergraduate students at public research university in the Southern Plains. His father received a bachelor's degree in telecommunications from a four-year public institution in the Southern Plains, while his mother received her bachelor's degree in elementary education. His mother did eventually go on to receive her master's degree in education from another public research university in the area. Xander is the oldest of his siblings, and the only one to pursue a degree in engineering. His younger sister and brother did complete degrees in business from a tribal college in the Southern Plains. Xander notes that he did not understand why his siblings went into business and he tried it before he switched to engineering and said it was "the corniest thing on earth." He said he "missed building things," so he made the right choice to switch back to engineering.

Raised in an urban metropolitan community, Xander said he attended a "predominantly black school" where he was one of only a "handful of Indians." Their educational pursuits led to Xander's belief that he would attend college. However, Xander had his share of struggles along his pathway to higher education, as he recalls being placed in remedial math and his high school

guidance counselor trying to push him toward vocational school. Fortunately for Xander, he knew he believed in his abilities, and pursued other avenues.

As a nontraditional student, Xander's path led him through two tribal college experiences in the Southern Plains and Southwest before landing at his current institution. Xander stated that he attended his first tribal institution "for all the wrong reasons," as he went there for "sports and not academic stuff," participating on the soccer and track and field teams. He obtained a bachelor's degree in American Indian Studies there, and then went on to obtain two associate's degrees in network management and pre-engineering from the second. It was at the Southwest tribal college where he discovered his "knack and fusion for engineering," due to the influence of a couple of professors and an academic advisor. He notes his experience with building his first circuit when he was 28 years old as instrumental in his major choice. While there, he first got involved with the American Indian Science and Engineering Society (AISES), and through their Tribal College Undergraduate Program, he interned with NASA. He participated in a Research for Undergraduates (REU) program in the Optics department at large, public research institution in the Southwest the summer prior. While there, he discovered the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) organization through his program coordinator. He ended up applying for several scholarships on their website and received a $500 one. Xander was thankful to learn of these organizations early on in his career.

Upon graduation, he decided to pursue full-time work and ended up landing a job at his current, four-year public institution. While working, he decided to go back to school because he enjoyed the information technology work he was doing, and had an influential academic advisor who was an electrical engineer for Sandia National Laboratories. Once he began looking at

degrees, he says that electrical engineering technology was ideal as he "had like half of the core electives out of the way."

Once Xander began school at his current large research institution in the Southern Plains, he had many stories of struggle to share. While he shares stories of impactful professors, Xander also noted a particular professor who caused him to retake several classes. Working full-time while in school also presented challenges, but the relevant lab work kept him engaged in work geared toward his future career. Additionally, he took on a leadership role in the American Indian Science and Engineering Society (AISES) on his campus, where he discovered a passion for recruiting others to the organization and helping them reach their career goals. Xander said when he first started in the organization, the attendance was low and that they did not attend the national conference. He started "physically recruiting people" in the sciences and engineering, and eventually was able to send 10 people to the last conference. His connection with peers, involvement in discipline-specific organizations, REU (Research Experience for Undergraduates) and internship experiences influenced Xander's persistence.

Now in his final semester of his program, Xander hopes to start his career as a network engineer or analyst, particularly since he has gained experience in this area working in the Information Technology department at his institution. Additionally, he wants his mom to move to where he is at and retire since she is still in his hometown further north. He emphasized his motivation for his career is "to prove high school and family members wrong, and second because my mom knows that I can do better." His advice to Native youth considering engineering is to follow their dreams and not allow others, particularly guidance counselors, direct you to a trade school. He emphasized:

> If they want to go into engineering and they have a guidance counselor who thinks that they'd be better at trade school, tell them no. You want to go somewhere and get paid for it. Don't let someone tell you to go elsewhere.

Engineering Student #3: Hank

Hank and I have known each other for just over 10 years, as he was a former student ~~of mine~~. We really got to know each other through AISES, when I was this chapter's advisor. I have met his family, we have attended several AISES national and regional conferences together, he would spend hours in my office, and most importantly, I was able to see him graduate with his engineering degree. Now that Hank is in graduate school, we have continued to keep in contact, and he visits me every time he comes to visit his family. Since he has been away at graduate school, I have still seen him at a few AISES conferences, where he usually joins our group for dinner or an outing. I feel that he has influenced my life as much as I have his, as he has been an ear to listen as we both have had our own hardships while completing our graduate degrees.

The afternoon Hank and I scheduled our Skype call we spent the first half hour catching up before we got into our conversation. Hank has a quick-witted personality, as he is always cracking jokes and laughing. I have always enjoyed his humor, so we share a few laughs throughout our conversation. Now I will share Hank's story.

Hank's Story. Hank is a current mechanical engineering doctoral student attending a private research university in the Southern Plains. He recently graduated from a large state flagship institution in the Southern Plains, obtaining his mechanical engineering undergraduate degree. Hank is from two Southern Plains tribes and two in the Southeast. Engaging in gourd dances, stomp dances and his Native American church growing up, Hank was connected mostly

to his dad's tribe. Hank grew up learning some his language, but not enough to be fully conversational. As an only child, he grew up in a rural area just outside of a city in the Southern Plains, which was situated between his mom's tribal grounds and family, and his dad's.

Hank recalls always knowing he would go to college, as both of his parents were attorneys for the Department of Interior's Bureau of Indian Affairs growing up. They wanted him to be a medical doctor since he could remember. Hank performed well in math and science and attended a satellite science and math campus nearby where he was able to take AP Calculus and Physics courses. His involvement in STEM hands-on science projects and competitions really sparked his interest in engineering as a potential career path, and he notes that he chose mechanical engineering due to everything he was learning having a "basis in the fundamentals of physics." He particularly remembers an instrumental moment his junior year influencing his engineering career path when they had the students create a "floatation vessel or a storage vessel that floats to see how much weight you can actually get in there."

Furthermore, since his parents were both alumni of a large state flagship institution in the state, he grew up visiting this campus and attending this institution's football games since he was eight years old. He was invited to visit well-known private colleges like MIT and Cornell, but ultimately his familiarity with the campus near his hometown and financial aid package played a role in his final college decision. However, Hank still had to do some scholarship searching to find funding to cover the expenses his financial aid package was not covering. Through AISES and some other external funding sources, he was able to get the support he needed.

During his undergraduate years, Hank attributes key engineering professors, staff, and his Native and discipline-specific organizational involvement to his success. He notes his involvement in AISES and a Native American men's fraternity as the two key organizations

where he gained many of his friends who he still keeps in touch with to this day. Hank notes that "having a good set of folks that were not even just in mechanical engineering, but within all the various engineering and technology folks" were a huge support to him. Through AISES, he was able to obtain internships at General Electric his first two summers. He notes how he was "a bit of a loner" so finding those study groups and peers in his major was difficult, particularly in his upperclassmen years. Particularly his involvement in undergraduate research kept him "personally invested in things." He became close with his professor, who was also his academic advisor, and he offered him a spot to do research with him for some pay over the next couple of summers. His involvement in the research led to him finding out about an undergraduate research program to prepare junior and senior-level students of color for graduate school offered at his institution. This offered Hank some extra support funding, as well as teaching him research presentation skills, and preparing him for the graduate school admissions process.

Through all of this support, Hank still experienced his struggles both personally and academically. He notes his junior year as particularly taxing as he had just started his major coursework and the undergraduate research program, which he says was a "real kick in the backside." Hank discussed how he had been a 4.0 student up until his junior year when he took Numerical Methods and "passed by the skin of [his] teeth," but was glad he did as he would have had to wait another year to retake the course. Additionally, he struggled making friends in his classes, as most of his friends were through Native organizations, and they were different majors. Then, when he fell a year behind due to dropping a class, he had to start all over trying to make friends in his classes. Hank describes his experience:

> I wasn't really involved with any engineering stuff, like Baja (competition team), which in hindsight I probably could and should have been. But, it was one of those things where

> I stayed involved with the Native folks and everything – both in and outside of AISES – mostly because whenever you're in your class you want to think about other stuff. So even with AISES, even with the other mechanical engineers, they were either older than me or younger than me so we weren't talking about the same stuff necessarily. It was just one of those things to just get my mind off of my classes and stuff – whatever I'm thinking heavily on at that time.

Through all of the struggles, Hank talks frequently about the impact AISES made on his persistence. He enjoyed the AISES national conferences as he would make connections with other peers at different institutions. He notes that "his first real set of friends in college was from that first national conference [he] went to" his freshman year. Hank also served as president of his Native American fraternity his sophomore year. He feels those leadership positions prepared him for "life outside of school." Furthermore, he emphasized his spirituality as giving him the ability to push through school, as well as many mentors, such as his research professor, the Multicultural Engineering Program director, his undergraduate research program director, and the director of American Indian Student Life. Hank even flattered me by saying that I, as AISES advisor during his time in school, was a major "pillar" in his journey. We shared some more laughs reminiscing on his experience and how much time he spent in my office.

Hank recently completed his master's in mechanical engineering at his current institution and is immersed in his research, with plans to complete his doctoral degree by December 2020. Upon graduation, he hopes to work at a national lab with 3D printing. He admits he is still trying to figure out fully what he wants to do, as he has considered going the professor route. Hank describes his dilemma:

> I guess it's either now just trying to figure out if I want to do the whole education thing. But a plus and minut to that you're an educator, but you are in control of what you want to research and things like that, which is pretty appealing to me. But then at the same time, if you go into industry or a national lab, you have a task that you're working on, but you also have a steady paycheck and you know exactly what you're doing. So I'm still trying to figure all of that out.

Hank's advice to Native youth considering engineering is to find mentors "that can build you up" and establish a "school family." Additionally, he adds:

> Have big goals for whenever you get into undergrad – whatever you are trying to accomplish and what you are trying to do after [college]. And then, you have to have built a good support system – that can either be through a fraternity, that could be through just having a close set of friends, and then also have mentors that are both in your department and outside of your department.

Hank concluded our conversation with caution to future college-going Native students with getting caught up in the partying scene and alcohol upon entering college. He shared some of his own struggles and those of friends who ended up dropping out early as a result. Hank adds to "always have your goals but then also be aware of things that can take away from that," as "little things can end up being big things later on."

Engineering Student #4: Bree

Bree and I have also known each other for just over five years, as she was a former student. In my professional role as director of engineering student life, I had met Bree as she became involved in the Multicultural Engineering Program, the Engineers' Club, and a Formula

One race car competition team. However, we really got to know each other through AISES, as she attended a couple of national conferences while I was advisor and served as a part of the officer team. I was able to witness Bree complete her chemical engineering degree in 2018. Bree and I have kept in contact as she started her professional career locally, and then eventually just moved out of state to work for another company. I am so proud of Bree, as she just bought and moved into her first home with her long-time boyfriend, and is even closer to home and family. When we scheduled our Skype conversation, we had to work around her busy schedule of closing on her house and moving in. I believe she had only been in her house a few days when we connected, and she was able to toggle the screen to give me a virtual tour and introduce me to her new dog, Obi-Wan Kenobi.

Bree has always been more reserved, but when she feels comfortable with someone, she will open up. I had reached out to her personally to see if she would participate, and she was quick to respond and be willing to help with this project. I appreciate her sarcasm and sense of humor she always exudes when we share stories. Even in telling me of negative experiences, Bree always saw a brighter side and added in sprinkles of humor. After all, this is how we find healing as Native people. Now I will share Bree's story.

Bree's story. Bree is a recent graduate from a large non-Native research university in the Southern Plains. Bree is from a Southern Plains and Southwest tribe and grew up in the Southern Plains area in a small, rural farm town where she graduated in a class of about 40 students. Bree emphasized that most of her classmates would usually go off and help with their family farms instead of attending college. Bree grew up close to her tribal nation, but was not raised knowing her language, traditions or ceremonies. She notes that "the language-speaking ended at my great-grandmother and she died when I was about eight."

As a first-generation student, Bree was fortunate to have parents that very much supporters of her pursuing higher education. Her father had grown up in a neighboring town and had attended a trade school when she was 16 and did refrigerant and electrical work. Her mother grew up in a neighboring state in the Southern Plains, where she received her GED when Bree was about 12 years old. Because Bree's high school only offered physical science and algebra as the top levels one could study in science and math, Bree attended a satellite science and math campus where she was able to take AP Calculus and AP Physics. Bree describes her high school experience:

> So my high school didn't offer any science or math beyond physical science. Physical science was the ending of your sciences, and Algebra was the top level that you could get that our high school offered, so I went to a satellite campus in a town nearby. I rode a bus at like 5 a.m. going back and forth to that in my junior and senior year to take AP Calculus and AP Physics. It was the fact I did well in it and just having a background in Algebra and I still did really well in Calculus. And so those teachers were like, you should probably look into engineering. It will be something good for you. So it was definitely those teachers that got me into it.

Her teachers at the satellite school were influential in that they encouraged her to look into engineering as a potential career. Still, Bree was unsure what she wanted to do upon entering college, so she started her freshman year as an undecided major.

Scholarships, notareity of the school, and proximity to home were important factors in Bree's college decision. When it came to finally making a decision to major in chemical engineering, Bree shares her story:

> That's actually a funny story. So nobody in my family has ever went to college or anything, so when I got to my institution, I didn't have a major. I was just wandering around. I think I was just general engineering. I didn't have a specific path that I was taking, and so I wanted to set the bar high. I went to one of my counselors and asked, "What's the hardest thing you can do in engineering?" And she was like, "Well, you should probably look into chemical engineering." And I was like, "I'll do it!" It took me about six years to get through it. [laughs]

Though she had confidence in her abilities to take on one of the tougher majors, Bree ran into her fair share of obstacles along the way. Bree teased that she felt like she wanted to give up about "90 percent of the time." One story she shared was about a junior-level class she took and while she had a passing grade, she recalls the professor failing her because he thought she "lacked passion and I think you should switch your degree…I don't think you have the abilities." Bree did not let his comments phase her, and she was back the next semester in the course.

Despite this incident and others, Bree persisted on with the support of her parents, peers, and organizational involvement in AISES and the competition racing team. When discussing her experience as one of the only women on the racing team, Bree states:

> I was on the racing team where we built a race car for two years. I didn't do it my last year, but my sophomore and junior years. It was really interesting. I think that's kind of what got me into wanting to do something other than actual chemical engineering once I got into my degree. I was already too far gone in my degree that I couldn't turn back, but I was going to finish it out and try to get something closer to what was doing on the competition team. So that was like electrical stuff or programming. And so now I actually have a job in programming.

Bree says she was really shy so she only had three friends in school, but through attending AISES national conferences, she was able to obtain internships with some big companies such as BP in Alaska. Additionally through involvement in undergraduate research, Bree had opportunities to spend summers in Turkey and Greece. For the Turkey internship, Bree noted that she "just applied to NSF and they picked my resume/essay" that allowed her to go.

Currently, she has a programming job working for a Fortune 500 company in the southeast, where she wants to get the company involved in recruiting at Native American conferences. Her career goal is to move up within the company to have more influence. Bree's advice to Native youth is that "where you come from doesn't define where you're going to go."

Engineering Student #5: Micah

Micah was the first engineering student that I had the honor of speaking to, and he set the standard high with his fun sense of humor and positive spirit. I really appreciated our entire conversation, as I could clearly sense Micah's passion for his research and future work in optics engineering. When we had our conversation, we spent the first 10 minutes getting to know one another, and sharing some laughs. Micah said he had wanted to participate because his cousin forwarded him my recruitment e-mail, and he is really getting engaged in outreach and wants to let future Native students know that "we are here." Now I will share Micah's story.

Micah's story. Micah is a current optics engineering senior attending a university in the Southwest. He noted how he is having to complete a fifth year before he can graduate. Micah is from a Southwest tribe, noting four clans he belongs to, and grew up in the Southwest. He grew up partly on a reservation and in an urban area. While he does not speak his tribal language fluently, he says he can understand a lot of it. He noted fond memories of spending summers at

his grandma's in a rural Southwestern town, where his aunts and uncles would speak their tribal language exclusively. Micah shares his reflections on visiting his grandma's:

> I really remember living on the reservation. I had a home that was actually pretty big. I had a really big backyard and a wide open front yard, too. And I think back then, you didn't really feel unsafe. I could play on the sidewalks and streets and play 'til it gets dark and then go back inside because like you didn't have an iPad or Xbox and stuff like that. When I was growing up, I was around other students like Apaches, so I didn't really feel different. I just felt it wasn't anything negative. Like when I found out that someone else was Navajo, I was like, oh cool, like I'm Navajo, too. Then, I moved to the city and then that was a whole completely different scene because it was in the city and I was at a public school and it was a pretty big school, too. The high school was like 6A, which is like a really big high school for sports or something. There a little bit of like racism or stuff like that. But it never really got to me. I think at that point I was just used to it. I don't really mind it now. It's always said. But from there to there, I would go to my grandma's, especially from living at the reservation and then up to high school, I would always go to my grandma's for summers… spend the entire summers there. Her house has a fence, but that's only to keep the sheep out, and the gates and the horses and things like that walked by. But other than that, you can run anywhere you want. It's just kind of hilly, like a bush area, but that's where I used to play. We had a corral of sheep that every day we would have to fill up the water and put it in the wheelbarrow and go wheel it over there, pour it out, and do that like twice at least. And then sometimes we sheep herd, like make sure that the sheep were fed and clean around the house. Like water the trees.

> Thinking about it now, it's kind of really peaceful. Compared to now, it's super busy… after this I got homework to do [laughing].

Micah says he still has those same feelings of peacefulness when he visits his grandma on the reservation. His parents split up when he was around three years old, and since then, he has lived with his mother and his three older siblings. He comments how "it's amazing how she [his mom] can raise all of us and take care of us, making sure we're doing good and every single time since…pretty much my whole life, like when we needed her the most." Micah expressed such admiration and respect for the matriarchs in his family as big influencers in his life.

Continuing to talk about his family, he notes he has two older sisters and one older brother. As he reminisces, he states that he mainly remembers it being one of his brothers and his cousins that visited his grandma's every summer growing up. Occasionally, he said his sister would come back and babysit for other families who needed the help there in the summer, and for her nieces. He emphasizes that they mainly went there "because they knew they needed help watering the sheep" and taking care of "a bunch of livestock."

Higher education seems to have been an expectation for Micah, as his mom had attended college in the Southwest, his two sisters graduated with degrees in the Southwest, and his brother is currently at his same institution. Micah notes that it's "pretty cool" having his brother around and that they are both on the same intramural basketball team. His college decision was heavily influenced by his family and proximity to home, and he grew up wearing shirts with this college's logo on them. Additionally, his fascination with engineering began in high school after an imaging activity with prisms. Ever since, he knew optics engineering was his interest, and his school of choice offered degree tracks in optics. Because he thought his institution only offered a master's in optics, he applied to the physics program and got in. Then, he realized they offered

an undergraduate degree in optics, so he tried to transfer into the program. However, Micah struggled acclimating his first year and his GPA dropped, which prevented him from transferring into the optics program for a while. He attributes his struggle to homesickness:

> This might just be like a Native thing or like a shy person thing or something, but I think we're all, I mean not all, but I think a lot of Natives are surrounded by family so much that when they're gone, they miss their family and their family misses them. Because when I was gone, I got Snaps and stuff of my nieces and nephews growing up and I was like, Oh man, I'm missing that kinda feel. And even then, because throughout high school I wasn't really outgoing. I wasn't really talking or anything or I have like friends, but I never really hung out with them except for like online, Xbox, things like that. So coming from that to being inside all day, being near family to having my own apartment, a freshman with no friends or anything and just going from this lifestyle to this lifestyle. It definitely was a huge change and I think that's kind of the same thing with everybody who leaves their family.

Micah worked diligently the following summer taking coursework at a local community college to get back on track, and his persistence paid off, though it added an extra fifth year to his program. When he returned in the fall, he did well in his coursework, and was able to apply and obtain an internship in the College of Optics through an optics program for undergraduate Native students, where he “tested what’s called a confocal microscope.” Though he was not really interested in that summer’s work, he was able to meet his friend from his same tribe who already was working in a 3D hellography lab during the academic year. Micah entered the same research program again the next summer, and his friend was in there with him. Micah describes the experience:

> So he invited me and then he kind of mentored me… during summer ’18 when we worked in his 3D hellography lab, which was really cool. Because he was already working in the lab and they already had a project going on, I just joined in on it and we completed it during the summer. We actually submitted and it got accepted for paper. So that was cool. And then I got invited to continue working in the lab during the year, so that’s what I’ve been doing.

Falling a year behind offered Micah the opportunity to meet another Indigenous person in a class in his same program. This gave him a friend who he could relate to, making Native jokes and talking about their families and upbringings, all while performing research in an optics lab. Eventually, they both published a paper on their research together. In fact, Micah shared the breaking news with me as the e-mail came in during our video call. He followed up soon after, sharing the research paper with me. Micah and his team currently making a heads-up display for a company called Honeywell, where they have been tasked with recreating a heads-up display to be put into aircraft. Ever since Micah has had these lab experiences, he has made all As and Bs in his classes.

Micah attributes his undergraduate success to the research internship experiences, peers, and organizational involvement. While we had our conversation, Micah primarily discussed his involvement with AISES and SACNAS, as he established many connections through these organizations. However, because the field of optics engineering is so new, Micah found that he was not able to connect with other optics majors through these groups to assist with any of his academic work. He attests to his experience:

> So I'll go to an AISES meeting and everyone there is either like civil or another engineering [major]. And the reason why I say that that it's different is because optics is still kind of new. Like if you look at like a civil engineering textbook, there'll be a textbook on anything that you want, but you go to optics and there's really nothing there. Like if you're doing like mechanical engineering, you can type in your homework and there'll be a thousand people asking the same question. Then, you type in my optics homework and you'll get like a Wikipedia answer or something with long equations. So I guess that's the only reason. I think optics engineering is a lot different just because of how there's not a lot of material, not a lot of standard material on it.

While Micah found AISES and SACNAS helpful in meeting other engineering students, he could not always relate with other majors since his major is so new. Furthermore, Micah also talks about his intramural basketball team as being another way he met friends since he says "most of my friends are outside of optics, so I don't ever see them unless I go to the games and play and then we get to talk."

Micah's experience has led to his love for outreach, as he gives many lab tours to Indigenous students. He expresses the importance of sharing his story and what has contributed to his success:

> It just like we got to somehow help Native Americans and the only way that we found to do that is outreach or just telling people our story. It's just like letting people know that we're in optics, but the only two [from our tribal nation]. There's maybe two other Native Americans, but I can only think of one, maybe two or three more. But we're the only two ones. Two [from our tribal nation] there. It's on us basically. And that's one of them. And

> then another one is… things like this. You asking or wanting to have me talk about it. But these things kind of keep me going because it's like, oh, people actually really care if people actually want to hear it.

Micah aspires to work at an aerospace company called Ball Aerospace in the Southwest, who collaborates with NASA on satellite work. He even mentioned the possibility of co-starting a company with his friend from his same tribe. Overall, Micah hopes to get a job post-college that will allow him to stay in one place for a while and buy a house. However, he says he is still "leaning towards grad school." Micah notes that he lives by a quote by an unknown author that says, "People are so afraid to fail that they don't even try." His advice to Native youth is "just don't give up" and keep going even when you fail a couple of times to "see where it takes you."

Engineering Student #6: Josefina

Josefina and I first became connected thanks to a dear colleague and friend ~~of mine~~ who works at a Native cultural center at a public institution. My colleague and I have known each other for a few years through our involvement in NASPA (Student Affairs Administrators in Higher Education) and we had just started working together more closely as a part of the Indigenous Peoples Knowledge Community leadership team. We had a phone conversation one day, and I followed up on my e-mail I had sent her in regards to my study. She said she had a couple of students she would recommend to reach out to me. I am so grateful for her kinship as she followed through, and Josefina became one of my engineering students in this study.

When Josefina and I got on the call, I was really impressed with her ease in sharing her story. I could hear confidence in her voice, and sensed that she is comfortable in her own skin.

She had a very easygoing demeanor and I enjoyed our conversation very much. Now I will share Josefina's story.

Josefina's story. Josefina is a current aerospace engineering junior attending a university in the Southwest. Josefina is from a Southwest tribe and grew up in the Northeast in a large, urban community. She lived there until she was 14, and then for her high school years, they moved back to the Pacific Northwest "because both sides of my family have family up there." She says she was grateful for her upbringing in being around people who "came from around the world," and that she was "exposed to all of these cultures in a small area." Josefina was raised as an only child, though she notes that she had a brother who passed away before she was born. Her father is Indigenous while her mother is "Scandinavian." She emphasized that her father went through boarding schools and orphanages, so he was stripped of a lot of his traditions and language early on. She shares this story:

> My dad was always worried about not being able to teach me our tribal language because he didn't know it. He spoke some of it at home. He left, or he was taken away from his home when he was a child, with a few of his siblings so he didn't get a lot of time there with his mom. But now and again, he'll tell me some words and after more research, I realized that he learned more Hopi because his family grew up [in another part of the Southwest] even though they're [tribal affiliation]. So any language he's told me has been a little bit of Hopi. We do have some cousins that are more directly from the Hopi reservation, so they know Hopi as well. Um, and then we, I, grew up in [the Northeast], so far away from where our roots were. My dad used to work at the Native American Indian Center of Boston as a tech guy, so I was constantly in the Indian center. There were some elders who would speak some languages, but I think I was too young to really

> remember any of that. So yeah, when it comes to language it's pretty scarce. But my tribe did recently launch, or a couple of years ago – last year – they launched an online language program for tribal members. So I've slowly been utilizing that and learning some words. Yeah, it's awesome. That was really great 'cause I'm not near my reservation, so I'm glad I still have access to learn this language.

So while Josefina did not grow up immersed in her language, traditions or ceremonies, she did spend a lot of time at a local Native American Center where she heard elders speaking various Indigenous languages, dancing, and beading regalia. Along with her tribe's online language courses, Josefina notes how she has enjoyed taking beading classes offered at her institution.

Josefina notes her parents as being influential to her educational success. Her father, who has a bachelor's degree in biology, is a Vietnam veteran, and has held a variety of jobs from a traveling guitar player, copper mine worker, semi-truck driver for 20 years, teacher for underprivileged kids, and a computer technician at a Native center. Her mother was a contract graphic designer while they lived in the Northeast, and then when they moved to the Northwest, she became a caretaker, helping family and friends with disabilities. Josefina said her parents' career journeys influenced her in that "it's made [her] think [she] want[s] to be an engineer, but [she] kind of want[s] to learn a lot of skills, like find an interest [she'd] like to delve into a little bit, not to get a degree in it."

Furthermore, when discussing her family, Josefina shared with me that she lost a half-brother before she was born, and describes her family as follows:

> So I had a brother… he was my dad's first child – a different mother – but he unfortunately died right before I was born. So kind of an odd thing when people ask if you're a single child, cause I'm like, I'm not, but I am because I never technically met him and grew up a single child household. My parents' situation… they were never together. I think they dated before I was born and then when I was born. Basically, as far as I can remember they were never romantically involved. They were never together. But we did all live under the same household until I was 16, which was pretty chaotic because they didn't really get along that well, but they did try to stay near me. When I was 16, my mom was like, you know what, I'm just going to move out and move close that way you still have both of us, but the house is intense, so that really made things like a lot easier.

Josefina considers herself fortunate to have had access to well-resourced school systems, where she was able to interact with the local universities at a young age. Consequently, she noted that she knew she wanted to be an engineer at six years old after seeing roller coasters at Six Flags through a local university's Native American youth education program, and wanted to go to college since she was 10 years old. She said her parents would "go out of their way to put me in the programs that would develop that interest so I could really get into it," which included building Rube Goldberg machines with her father. Additionally, she attended that same Native American youth education program for many summers, and in middle school, she got involved in Math Olympiad, Academic Games, and Science Club for Girls.

While Josefina lived in the Northeast until she was 13, her family moved back to the Northwest be closer to some family. While in high school there, she says she did robotics and "absolutely loved it." However, then she started looking into astronomy due to the influence of an influential astronomy teacher her junior year, who opened Josefina's eyes to the world of

aerospace engineering. Since she says she still was not sure what engineers did, she was open to further exploration. This teacher invited her to participate in an astronomy camp. Josefina said it was "always a great time in his class," so she chose to attend the camp, and that's where the teacher and her had a discussion about future career paths. Josefina notes that the teacher said "you can still do something with astronomy that incorporates engineering, like aerospace engineering." Once she did her research looking more into aerospace engineering, Josefina saw a lot about "rockets" and knew she wanted to do it.

When it came time to making a college decision for Josefina, she attended a college festival and looked for schools that offered aerospace engineering. Due to her newfound love of nature upon moving to the Northwest, where she said she "fell in love with the trees out there," she narrowed down her college choice to those close to nature and hiking opportunities. She also knew she wanted to go out of state again as after her first move, she really enjoyed the "fresh start." While looking at institutions that included nature and aerospace engineering program offerings, Josefina closed in on her college decision. She turned down opportunities at a couple of private institutions because this public institution had something fascinating that she describes here:

> I went through the information packet they sent me after my acceptance and I saw a water program they they have – a water purification program. And at the time, I had just learned about the state of water rights and water quality down on the Navajo Nation. I was like, you know, this seems like a good path for me. This school seems like it has something that I could learn to hopefully pass on to others. So that was kind of the point that just made it click.

Additionally, Josefina adds that scholarships were a deciding factor and that this institution offered her in-state tuition and scholarships, making it much more affordable. While she has still had to take out a few loans, she said she has gotten quite a few scholarships to offset the costs.

Josefina attributes her success to her parents, participation in the labs, organizational involvement and the community at the Native cultural center on campus. She spoke broadly about experiences with bad grades and how engineering was "much more harder than [she] thought," which sometimes made her question if she should be doing this. However, her love for the labs where she got to "build things," were most impactful to her persistence. She said they taught her that engineers do more than just "crunch numbers and do exams," but that she can "learn and improve [her] skills through these labs which [she] was able to do and that really reassured me." Furthermore, she emphasized the community at the Native American Cultural Center made her "feel much more comfortable here." She speaks further about her experience:

> In AISES, it made me feel like, "okay, so I'm not the only Native American engineer," because my classes – they're super white male dominated. Yeah, like especially male dominated. Sometimes you walk in some of those old classrooms and it just smells like a gym locker [laughing].

At the time we talked, Josefina shared that she was the current president of their college chapter of AISES, as well as being involved in the American Institute of Aeronautics and Astronautics, Astronomy Club, and then a multicultural advisory board that reports to the President. She is also working on a satellite project with some other AISES students, and occasionally attending Women's Circle through the cultural center. Josefina describes how these organizations have impacted her:

> And those have impacted me…so with like AISES, it's kind of an empowering thing. It's like, okay, this is a whole community for Native American scientists and engineers. It's something that's built up and there's support there. The aeronautics club has just kind of reinforced my aeronautics knowledge, like building toy rockets, listening to people from industry give talks… and then astronomy club is more of a hobby club. Just last night we actually went down to an observatory [locally] with a group of like six people I think and we had a great time. We just learned about radio astronomy and then used the observatory that they have to go look at stars and all that. So it's nice. And then [the multicultural advisory board], I think that one's got me more into the political side of [my institution] and just the very, very local politics. It's kind of like what happens behind the scenes of [my institution], outside the classroom, how things are managed essentially. And really the relationship that [my institution] has with its multicultural students.

Josefina has had one internship thus far. The summer before she entered college, she worked at a proton therapy lab at a general hospital in the Northeast. She says they would provide radiation therapy for cancer patients on the weekdays, and then use the equipment to test space equipment under radioactive environments on the weekends. She was able to interact with several space companies that came in each weekend. This summer, she is interning with Sierra Nevada Corp, where they are currently working on a shuttle for the international space station. Her career goal is to work in research and space exploration at NASA.

In Josefina's recent outreach work participating in a Native American STEM Institute, she was able to spend a week with local Native youth doing intense STEM exploration. This influenced her advice to future generations of Native students:

> I think from that, like that really showed me there are some kids out there that already have great support and they know what they want to do. And then there were some kids that didn't have that greatest support and they were just kind of, you know, going through life day by day, not really sure what they wanted to do. I would say for those kids who were like, I don't know if I can do this, that's not something I really see in my life, that doesn't seem doable for me. I strongly believe in the phrase of "Be your own hero". So I would say to future generations, like, you don't have to follow anybody's footsteps and you don't really have to follow anybody's plan. Like you really can do exactly what you want to do. It's going to be hard sometimes, but you know, you really can be the person you want to be.

Engineering Student #7: Marcus

Marcus reached out to me via e-mail with interest in my study as a result of the same colleague and friend that connected me with Josefina. He was very eager to help out, and we were able to schedule a conversation within a week's time of his initial response. While our video conversation was shorter than most, Marcus was able to tell me a lot of information in that short amount of time. Marcus completed the reflective journal, which provided more rich stories of his experience, which is included in his story. After reading through his transcripts, I sent him some follow-up questions to expand upon, and he responded quickly. Marcus was very easy to talk to, and had a very laid-back demeanor. Due to my having some connections with his dream company, I put him contact with some former students I know who work there. I am hoping this helps him in some small way to kick-start his career. Now I will share Marcus' story.

Marcus' story. Marcus is a current mechanical engineering junior attending a university in the Southwest. Marcus is from a Southwest tribe and grew up in a small town close to a large Native reservation in the Southwest. He helped his dad on their small farm there. While his grandmother speaks their Indigenous language fluently, it was not passed down to his mother, since his grandmother attended boarding school where she could not speak her language. His parents always encouraged him and his younger brother to pursue higher education, and his mother has both a bachelor's and master's degree in education and worked at Board of Indian Education schools during his childhood.

Engineering was an attractive pathway for Marcus as early as middle school. Due to his parents' encouragement, he took advanced classes in high school via a "Honors Diploma graduation track." This track offered Marcus AP coursework, of which he focused on "math and science since [he] had a desire to attend college to study engineering after [he] graduated." Since his small town had "quite a large industry for natural gas," Marcus remembers one his dad's friend's – who worked for a pipeline company – talking about the different jobs engineers would do at local oil and gas companies. He describes that experience further:

> That always peaked my interest. And then the more I learned about engineering, the more I found out what kind of stuff they do and what other fields they could branch out in to. And that really helped me move in that direction. And then also in high school, I had a math teacher who used to be a chemical engineer, and I ended up having her for…I guess it would be like my homeroom. But I had her for math and homeroom and she really inspired me to keep moving on into the field.

Furthermore, his mother worked as an education director on a local reservation, so she had connections at the university he would eventually call home. Her connection was impactful on

his college decision as they would visit often, so he was already connected with staff at their Native cultural center. He says “felt more of a connection here” because he “already had a family and [he] already felt like there was more of a community.”

Mechanical engineering sparked Marcus’ interest when an alumnus from his high school who was now an undergraduate engineering student came back and spoke about his experiences. Marcus reported that “the stuff that he would talk about really inspired me to go into engineering.” In addition, he took a tour of a local aerospace company, Lockheed Martin, his senior year, and was fascinated by the satellites and rockets. While Marcus struggled to keep his grades up his first year, he sought out resources and retook classes the following summer to be admitted into the mechanical engineering program. Micah shares that story here:

> The biggest obstacle I have overcome was getting into mechanical program. So when I first came in I told you that it came in as an open option. And so I applied to get into the mechanical program here, but it's limited to a certain number of students. So I applied once and then due to one of my grades my freshman year, I wasn't able to get in. But over the summer, I was able to retake the class and I was able to get in. And that is what has really kept me here. I don't think I would have been as happy choosing a different major. I was actually taking a few of their classes for a few other majors and they just didn't peak my interest as much. One of the things that also has really kept me here is just the community that I've had at the [Native cultural center] office. Really great people to get to know, a lot of different resources. It's just been really helpful.

The community at the Native cultural center, organizational involvement, tutoring, and his peers motivated him to persist. Marcus credits some of his friends in his major as being helpful

because he could discuss common struggles and confirm he's "not the only ones struggling through it."

Along with AISES, Marcus emphasized his involved in a president's multicultural advisory council as being instrumental to his feeling a part of the community at his campus. He discussed the advisory council:

> So, it's – the way [my institution] is set up we have, I don't even remember how many different diversity offices, but we have representatives from each of the offices that all sit on a panel and talk with the administration about every other week about different issues that are affecting our communities. And it just gives us time to be direct with the administration and talk with them openly about different things that we feel even need to be addressed or need to be changed or that are just affecting the communities overall. And honestly, I don't think it's something I would've ever done on my own, but [a Native cultural center staff member] actually approached me my freshman year, and asked if I would be willing to sit on that panel on and join. And it's been really eye-opening.

Besides getting a few low grades in some tough classes like Physics II, Marcus indicated that he really has not experienced any incidents in or out of the classroom that have made him unmotivated. While Marcus' future aspirations involve working for an aerospace company, he said he just does not want to be "stuck behind a desk," but rather "working hands-on with something, designing projects." Additionally, he hopes to get his student loans paid off. Marcus shared a final few words of advice for future Native engineering students:

> Find a community of people who will help you. The NACC office really helped me in that first semester I was here, especially the tutoring I was able to get from them and the

different support that we had. Just other people to talk to you about struggling through school. Attend office hours. Literally go to any resource that will help you. You know, it was one of my biggest issues my first semester. I was just not willing to find other resources that would help me. I was kind of, just scared in certain senses, just kind of intimidated. I didn't quite know too many people yet.

Summary

It is my hope that these stories of the seven engineering students will ignite non-Native administrators, faculty and staff to their stories of success in engineering to discover Utiyvhi. Additionally, their stories share important information for tribal nations and tribal colleges, in assisting students in preparing for the transition to four-year public NNCUs. Utiyvhi is only achieved by maintaining social and spiritual harmony internally, socially, naturally and spiritually. The next chapter bridges the seven engineering students' pathways in a relational and collective way that leads to lessons learned from their sharing experience through story. Though individually unique and powerful, their collective stories share interconnected elements that weave together more powerful collective teachings.

Chapter Hisgi (Five): Findings

Coming Full Circle to Reach Utiyvhi (Balance)

As I work toward finding Utiyvhi (balance), I have turned to the Cherokee four cardinal directions, as a way to think through the seven engineering students' stories and truths (see Figure 5.1). This graphic portrays the relational flow and connection that all four of these elements have with each other, and in continuing the conduit of sharing so that future generations of Indigenous students may succeed in engineering majors at four-year, public non-Native institutions. This chapter highlights the lessons that were cultivated from the seven engineering students in this study, who represented various gender identities, tribal nations, engineering disciplines, and institutions (see Table 5.1). The four lessons from the students' stories begin with understanding how nurturing early connection to STEM during the early childhood years impacted students' engineering pathways; recognizes how systemic challenges were overcome in their programs; indicates how community was built to connect the students with their discipline and campus; and focuses on experiential learning opportunities that allowed for a sense of belonging within the engineering program and profession. Finally, at the core of this circular path was the seven engineering students' maintenance of their cultural identity through connection to their communities, indicated by the sacred fire that symbolizes strength and unity as they come together in a more powerful, collective way.

Figure 5.1 Utiyvhi in Engineering Model

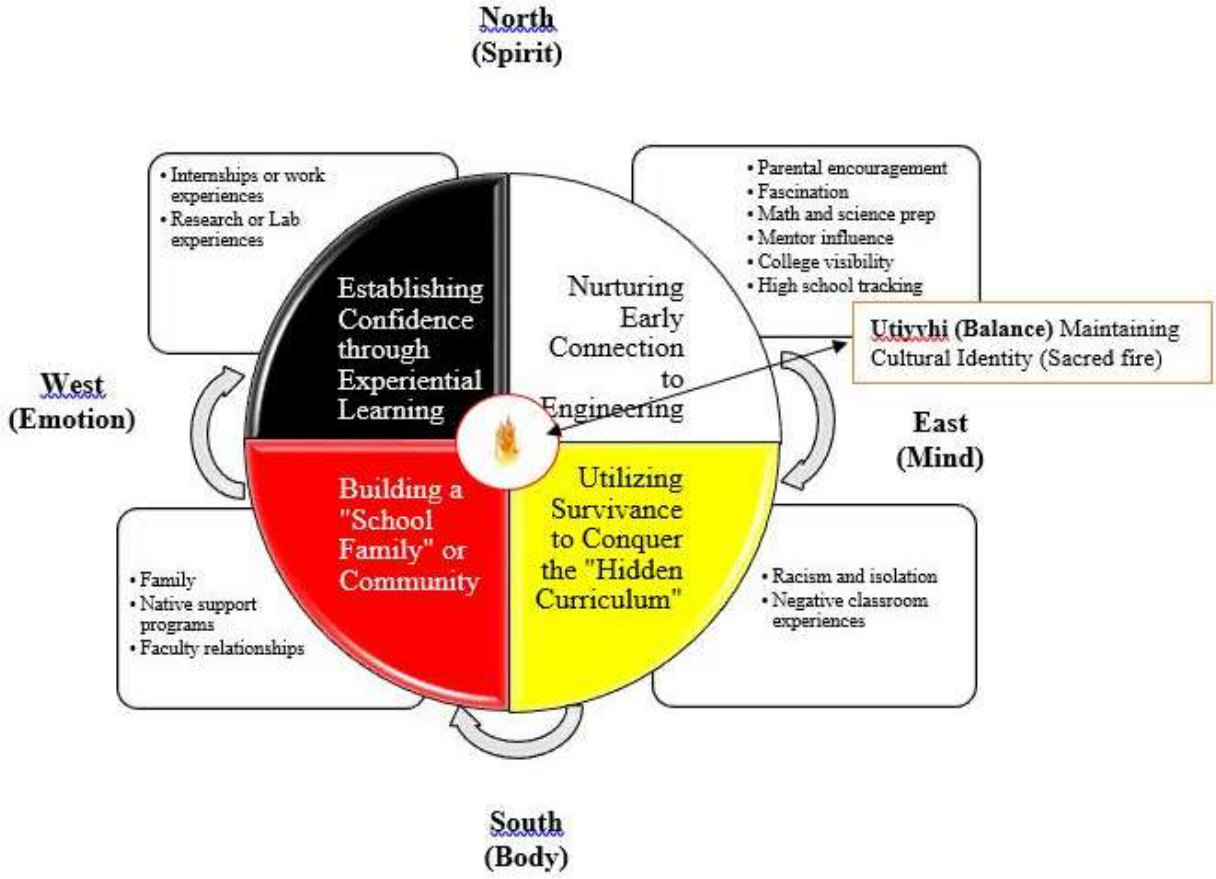

Table 5.1 Engineering Student Demographics

Engineering Student	Gender Identity	Age Range	First Generation?	Major	Tribal Affiliation(s)
Quetzalli	Woman	36-40	Yes	Civil Engineering	Northern Mexico tribe
Hank	Man	26-30	No	Mechanical Engineering	Two Southern Plains tribes; Two Southeastern tribes
Xander	Man	36-40	No	Electrical Engineering	Two Southern Plains tribes
Bree	Woman	20-25	Yes	Chemical Engineering	Southern Plains tribe; Southwest tribe
Micah	Man	20-25	No	Optics Engineering	Southwest tribe
Josefina	Woman	20-25	No	Aerospace Engineering	Southwest tribe
Marcus	Man	20-25	No	Mechanical Engineering	Southwest tribe

Nurturing Early Connection to Engineering

The first lesson begins in the students' childhood and early education years. In particular, it involves the ways in which an early connection to engineering was nurtured in the home, in school, and through other impactful experiences. No matter the education of the students' parents, education was a valued component from early on. Two of the seven students were first generation students, though parents' vocations were still able to influence their career trajectories. Additionally, majority of the students were exposed to college environments in their local communities from an early age, which made higher education visible and attainable. In most cases, the students attended schools that exposed them to higher levels of mathematics and science, which led to influence of teachers and other role models telling them about engineering as a potential pathway. Still, the two nontraditional students in this study had negative engagements with high school counselors who kept pushing them toward vocational school instead of college.

Parental encouragement for education. Six of the seven participants had a parent or both parents who began encouraging them in their educational pursuits during their K-12 experiences. Xander describes his mother as his "biggest motivator," and "she is the person who pushed me to further education." He further notes that once she received her master's in education that he and his siblings were excited and knew that "if she can do it, we can." All participants identified having supportive parents or grandparents who influenced their college attendance. Research has supported parental encouragement and support as the most influential factor in a child developing aspirations for college (Hossler, Schmit, & Vesper, 1999; McDonough, 1997), and in particular for Native students (Brown & Robinson-Kurpius, 1997; Lundberg, 2014; Lundberg & Lowe, 2016; Mendez et al., 2011; Shotton et al., 2013; Shotton,

Oosahwee, & Cintron, 2007; Waterman, 2007). Quetzalli spoke of her grandfather's influence on her pursuing a college education, but also his stories sparking her interest in a career in "building buildings." At the age of 10, Quetzalli remembers:

> I learned a lot about how my grandfather made his structures where he lived. He made them out of adobe, and he told me how when he was taught to build houses, then it's important to use natural resources that we have as important to respect our natural resources, our earth. He wasn't fond of concrete and he explained to me why. And he's like, this is made out of mud and straw and stone, and this is how our ancestors did it. He's like, I don't understand why these other people are making structures that they don't know how to work with material. You can't undo what you do, and you can't give it back to the earth. And so when he spoke like that, it really touched me like, his thinking, right? Like the amount of respect that we should have for our surrounding environment.

Her grandfather, as an elder in her tribal community, had much wisdom to share with Quetzalli that resonated with her in thinking of her future. This is a prime example of how Indigenous knowledge is passed down orally to generations, and how it conflicts with Westernized ways of knowing. Her grandfather emphasized the *relationship* that their people have with the land and its resources before and during the construction of structures. This relational component was really fascinating and meaningful to Quetzalli, and it influenced her career trajectory.

Furthermore, Marcus' mother received her master's degree in early childhood development and worked in many BIE schools when he was growing up, and he recalls that she "really pushed me and my brother to make that we're doing well…that we're aspiring to the best of our abilities." He also mentioned his dad being supportive as well. Josefina also notes that

because of where she grew up (urban area in the Northeast), she was surrounded by great schools. She goes on to say that:

> I grew up there because my parents, especially my mom, she really pushed, she's like, I want her to be in [this city]… I want her to be near really great schools and they have a good public school system as well. So they really pushed education for me as like an importance in my life. And luckily I've been able to hold that value throughout my life. I know knowledge and education has always been something huge for me. And I think that really impacted me, as I wanted to be an engineer since I was six and I wanted to go to college since I was like 10. That's always been a dream for me because I was around it… I was in an area of where it was very possible. It was very doable and it was very normal.

Hank's experience was similar in that his parents were both practicing attorneys for the Bureau of Indian Affairs growing up and they pushed him towards college and wanted him to be a medical doctor. For Bree, college was always encouraged even though her parents did not obtain college degrees, but her mother got her GED when she was around 12 years old, and her father went to trade school. Micah's mother received her bachelor's from a local institution in the southwest, and he had older siblings who also went on to college, which made college seem like a normal rite of passage.

Fascination with a phenomenon. As early as six years old through high school, all of the participants experienced a vivid moment of *fascination*, whereby they realized their interests in engineering. Fantz, Siller, & DeMiranda (2011) support that early exposure to toys or hobbies developed with engineering principles in mind, may be an influence in children's future pursuit and success in engineering (p. 606). Furthermore, Fantz, et al. (2011) found the connection of K-12 exposure to engineering content, whether formal or informal, as associated with higher self-

efficacy in engineering (p. 615). For Josefina, she recalls the exact moment when she recognized what she wanted to do:

> So I had gone to Six Flags when I was six because [a local Ivy league institution] had a Native American youth education program. I believe that's the name of it. It was a Native American based summer camp. And I used to go there every summer when I was a kid. And that was my first summer there and they took us to Six Flags and we stepped out the car and I saw this big red roller coaster and I was like, "There we go. That's it. That's insane." Like my little six-year-old mind was blown. So it was like, wow, I want to make those. Then, I told my mom and my dad when I got home and they were like, "Well, you can be an engineer and do that." And I don't know…that got me excited because I was like, "I could actually make roller coasters."

She further discusses how she and her father would make Rube Goldberg machines, which uses everyday supplies to create a contraption of 20 steps or less to cause a reaction.

For Micah, his moment occurred in his physics class in high school when they used prisms to see how light would penetrate a piece of paper and cause an actual image to display on it. While that moment had him in awe, he also remembered another moment with lasers:

> Lasers are cool. There's one moment that I always remember, but I don't know if it's really special to anybody else, but to me it's like kind of special. It was the first day of lab and they had like this really cool lamp. It was like one of those, like you know, it's like a really big overhead lamp, like this, and it has like a white light, kind of not like this light. It's a little brighter, is bright white and it's like, I guess you know how surgery tables that have a huge lamp and they have their gloves on and they have darkness all around them.

> So for me inside the lab it was dark and I had the lamp like right here. And so the lamp was right here but, and there was a big lens inside and I was like a magnifying glass. So I will look through it and we were like cleaning different lenses. And so I had these gloves on, but they weren't like full gloves, they were like fingertip gloves that you put on. And I held up the lens to the, under the magnifying glass into the light and it was just like a picture. It was like a poster in my hand and it was like a really nice piece of a really nice lens that was clean and had like, it was fully lit and around me it was dark so he was the only thing else focusing on. And wow, it's just like super cool.

Furthermore, for Marcus, he noted a facilities tour of Lockheed Martin his senior year as being instrumental in his major decision, as he go to see the "rocketry and satellite programs there." Quetzalli had early influences when her father took her to his work on a construction site, where she was "exposed to wood frames," and would "put on his tool belt and play around with it." Additionally, she recalls a defining moment in her community college experience in a physics course that solidified her path to engineering:

> So I left and I took physics, my first physics course and I fell in love with it. I was like, wow, I did not know this existed. I had so much fun. It was like brain candy to me. Especially when we were applying the calculus right in natural phenomenon. I'm like, oh, this is amazing, this is awesome! And I learned that I really liked physics because of the calculus involved in it. And I decided to look into engineering and I was like, okay, maybe he [her counselor] is right. Maybe I should look into engineering.

Similar to Quetzalli's experience, Xander discovered his love for engineering after he had received his first bachelor's degree and went on to a two-year tribal college in the southwest.

This is where he built his first circuit and he go to take “one of their little remote control cars and I was like, okay, let’s make this thing work.” Hank also had a monumental a-ha moment at his math and science satellite campus in high school when they “had to create a floatation vessel or a storage vessel that floats to see how much weight you can actually get in there.” He emphasized this moment and other projects as being impactful to pushing him toward engineering. Consequently, seeing tangible items in action truly produced a fascination with each of the participants that influenced their love for STEM early on.

Math and science exposure and preparation. For five of the participants, early exposure and fostering of an emphatic love for math and science also influenced their connection to STEM in general, and later engineering. Pajares (1996) cites six studies that reported that mathematics self-efficacy is more predictive of college undergraduates‟ interest in and choice of math-related courses and majors than their previous level of math achievement. For Bree and Hank to access more advanced math and science coursework, they had to attend local satellite campuses that offered them. They both were able to take AP Calculus and AP Physics to prepare them for engineering majors. Micah notes that while he did not have access to AP classes and was an “average student” in high school distracted by video games, he got decent grades overall without much studying. He did reminisce on a moment when he “a near 100 in my pre-calculus class.” Josefina’s math and science exposure came in the form of getting involved in high school academic activities, such as Math Olympiad, Academic Games, Robotics Club, Science Club for Girls, and attending an astronomy camp.

Unlike all of the other participants, Quetzalli discussed how school was her “escape” from her negative home life full of alcoholic and domestic abuse. She does emphasize how she

"always loved math," though school officials kept placing her in remedial math. When she arrived at community college and experienced her first physics course, she knew engineering was her pathway. Likewise, Xander was also placed in remedial math in high school, but discovered his talents in math and science during his tribal college experience.

Mentor influence. In addition to early exposure to math and science, all participants discussed positive influences during their K-12 or community college experiences – prior to attending the four-year, public non-Native institutions. Most of these mentors were teachers, counselors, practicing engineers, or a parent in some cases who pushed each student toward an engineering pathway. Josefina remembers her junior year high school astronomy professor, who she described as "super nerdy, but he owned it and he loved it." She disclosed that "he was happy to teach kids and liked using a lot of play in his classroom, not just lectures but all these toys and demonstrations and things to be hands on." He is the person who invited her to attend the astronomy camp, where afterwards, they discussed Josefina incorporating astronomy into her future career. Once he brought her attention to aerospace engineering, Josefina says she "looked more into it and I was like 'rockets, yeah, I can do that.'"

Bree also mentions that after her doing well in her AP math and science classes that her teachers told her to look into engineering. She recognizes those teachers as being influential in her decision to look into engineering. Marcus also recognized a math teacher who used to be a chemical engineer having a major impact on his deciding on mechanical engineering. Additionally, "one of my dad's friends was actually working for a pipeline company there [in his hometown] and would always talk about the different jobs as engineers would have for these oil

companies and what kind of stuff they did." Furthermore, he described another significant moment:

> So there was a student who attended my high school as well. He ended up going to Stanford, but him and his sister would always come back and visit the high school. Their mom was a counselor … but they'd always come back and he went into engineering as well. And just some of the stuff that he would talk about really inspired me to want to go into engineering as well.

Marcus had several role models in his pre-college experience that guided him toward his degree path. While not noting any high school role models, Quetzalli states that after having several negative counselor experiences at her community college, that she finally found one who was supportive. She describes one of her conversations with him that led her to her love for physics and eventually to civil engineering:

> The first day was there I went to see him and he met my daughter when she was only a year old… or I think it was like seven months or eight months old and um, and he knew everything that was going on with my mom, with my brothers. Every challenge. And sometimes I didn't have anyone to talk to and I would just go in there and I'm like, I'm going through this and they don't know what to do. And he was the one who told me "Well, Quetzalli, you can't change your major again." He's like, "You have to move forward. Have you taken any physics courses?" And I'm like, no, I haven't because I took a physics course and I'm pretty sure I didn't like it. And I'm like, why do I need to take a physics course? And he said you should consider doing engineering. If you wanted to do architecture, but it sounds like you want to do something with a structure. It sounds like

> you want to do engineering, but I'm not sure yet. And I'm like, what is engineering? And he's like, well, why don't you do your homework and find out.

Having mentors at various points along their journey to their four-year public institutions provided motivation and belief in their abilities to pursue engineering. In most cases, they would not have thought of engineering as a viable career pathway if it were not for these mentors.

College visibility. For the five traditional students who went straight from high school to a four-year, non-Native public institution, visiting college campuses for various reasons throughout their K-12 experiences impacted their not only attending college, but their selection of type of institution. Micah had an older sibling attend the southwestern institution he would eventually choose as his collegiate home. Additionally, he notes how his whole family were supporters of this institution and that the proximity to home was also a factor. Micah adds:

> …the university was already number one on the list before I even…like in high school I was wearing the university's shirts all the time. Like I would watch all the games with my family and even then like the campus is not, not too far from home, but it's also far enough from home where I can be on my own. And then the location is very college town. I mean, it's not big, but it's definitely city-like.

Bree also chose her institution based on close proximity to home and because of her institution's notoriety in sports. Marcus discusses how his mother was an education director for a location reservation and that she "had pretty good connections up here" with the Native cultural center. Plus, he had family in the area so they were visiting frequently and they would often visit

the college campus and the Native center. He further describes that moment when he had to make his college decision:

> And so when it came down to my senior year, I was deciding between a southwestern institution and this institution. I just felt more of a connection up here because I already have family and I already felt like there was more a community here that I could just reach out to rather than trying to seek out if I went to the other school, because I didn't really notice any other communities that I can just like immediately reach out to and get help from.

Furthermore, Hank also had familiarized himself with his local institution since he was eight years old. His family took him to many football games and he says he had a "foothold" in the town and was more emotionally attached to the institution. As for Josefina since she was already used to moving so much, she wanted some place that would keep her close to nature. In addition to this institution being "nature friendly" with mountains, she attended a college fair where she saw they also had aerospace engineering. She recalls this moment:

> My mom told me, go through all of your colleges one more time that you got into and just check them all one more time. And I went through [my institution's] again, like the information packet they sent me after my acceptance and I saw a water program that they have, like water purification program. And at the time I just learned about the uh, the state of basically water rights and the water quality down on Navajo nation. I was like, you know, this seems like a good path for me. This school seems like it has something that I could learn to hopefully pass on to others. So that was kind of this point that just made it click.

College visibility during the participants' K-12 years was impactful to their matriculation to college later on, as well as aiding in the students' college choice. Proximity to home was important for most of the five students, while other factors such as programmatic offerings and relevant cultural messaging made a difference as well.

High school counselor tracking. For the two nontraditional students Xander and Quetzalli, they both experienced a form of tracking from high school counselors. Xander's high school split his class into two tracks, and he was put in the remedial class. Then, his high school counselor insisted he attend vocational school. Knowing better, Xander said "I want to do more than just this," and he left to attend a four-year tribal college to earn his first bachelor's degree. As for Quetzalli, she recalls the interaction with her guidance counselor quite vividly:

> I had asked my counselor for guidance and she gave me an aptitude test, to kind of decide what career you should go into, and she said that I was going to be a farm worker. And I was like, okay. I struggled a lot in high school because I was placed in remedial math every year, even though I still learned in Algebra and Geometry, I was placed back in remedial math. And the reason I knew it was remedial math because I saw all my brother's friends, which were gang members. And I was like, this isn't a class for me, this is not a class for me. And we went through the same thing, which was adding, learning how to add, subtract and multiply fractions. I'm like, I already know how to do this; I learned this in middle school. And so I remember that one of the challenges was going back to the counselor's office and saying, you have to take me out of that class because that's not a class for me.

Like Xander, Quetzalli was placed in remedial math unnecessarily and had to advocate for herself. Since neither one of her parents had a college education, they did not understand how to assist her. Fortunately, for both Xander and Quetzalli, they had confidence in their abilities to move beyond what their high school counselors were sharing with them.

Utilizing Survivance to Conquer the "Hidden Curriculum"

The second lesson progresses into the participants' undergraduate years at their respective four-year, public non-Native institutions and discusses the major challenges and failures they experienced along the way. More importantly, this section covers how the participants' overcome barriers that could have potentially derailed their pathways to the engineering profession. Micah describes how he persisted through his own challenges in his engineering program:

> I just was like, I'm not going to give up. I guess you'd call it "grit," where you just don't stop. Which for me, I've been through a lot of stressful times now that it's like I'll have five assignments due on Wednesday or something, and then it'll be Monday and I'm super stressed out. But at this point, I know I'll have it all done by Monday. I'm not going to just not do it. It'll be all turned in on Wednesday and I'll get a good grade for it. So like, why am I stressing now when it's going to be done.

Duckworth (2016) noted that *grit* is how people process the feelings associated with frustration, failure, and setbacks that determine if they will persist. Micah described grit as how he persisted through classroom challenges as being able to persist despite failures. He quoted Kanye West in saying that "people are so afraid to fail that they don't even try," and that this quote really motivated him. Ho\wever, there are scholars who push back on the use of the

language “grit” for students of color because the concept fails to recognize privilege as a factor to success, and the systemic barriers for students of color and those living in poverty (Golden, 2015; Nathan, 2017; Perry, 2016). The use of the word “grit” reinforces settler colonial norms of just dealing with systemic racism and inequitable systems. We are assimilated to adopt this language as our own, not fully understanding how these norms continue to perpetuate systems of injustice, instead of seeking to decolonize and dismantle them.

Utilizing language that resists these dominant norms, Vizenor (1998) presents the concept of *survivance* in articulating the uniqueness of the Indigenous experience with persevering in hostile contexts. Vizenor (2008) often utilized survivance in opposition to victimry, in that it was more than mere survival, but an active presence and resistance to erasure. Furthermore, Deloria (1970) further posits that survivance, which combines survival and resistance, calls for adaptation and strategic accommodation in order to survive and develop processes for community growth. Survivance better articulates the students’ experiences holistically, as they each used different language to place meaning to their experiences in overcoming immense challenges that particularly call attention to systemic issues. For example, Quetzalli also described how she “developed a thick skin” that allowed her to move past the racist comments and culture that are common in these engineering spaces at non-Native institutions. She describes her experience as follows:

> Students are not all very nice, but I’ve been through this before that I’ve developed a thick skin that I don’t care anymore. So if they don’t want to help me or get together to do the homework, that’s fine. I’ll figure it out on my own anyways.

Furthermore, Quetzalli brought up the “hidden curriculum” that is dominant in higher education, and particularly in engineering and STEM pathways. Quetzalli asserts:

> I like to think of it as corruption. Hidden corruption, right? The hidden curriculum that's in the education system. The plan that the dominant culture has for underrepresented minorities and not make it noticeable, and that's really the key. That's really how they've been able to surpass, or be successful in that they don't make it obvious, right? In that they have a hidden curriculum. They gave me the opportunity to go to this institution, but they didn't support me. They didn't provide resources. They just opened the door, threw me in the ocean, and it's either sink or swim. And I struggled. I drank a lot of salt water to continue swimming. But how many underrepresented minorities sink? And how many survive? Any why were they able to continue swimming? What was the kind of preparation they had in their K-12 experience? Because I now realize I was very fortunate in the K-12 system I grew up in, but not everyone has that opportunity. And so it's really understanding how to play the game and to choose if you want to play the game because not everyone wants to play the game. Do you want to play the game? What are the rules and how do you surpass the dominant culture? And I think that's what really brought me back and that's' what keeps me motivated.

Quetzalli recognizes there is a game being played at these non-Native institutions that were not built for us as Indigenous peoples. Again, though she does not explicitly name the concept, Quetzalli is recognizing and utilizing survivance as a means to continue her quest for her engineering degrees. It has then become a mode of motivation for her, as she becomes more awakened to the inequitable, hegemonic systems at play.

Additionally, she brings up the concept of *hidden curriculum,* which was originally introduced by Jackson (1968) as this form of socialization into the professional world and students' resistance with aspects of professional expectations (Margolis & Romero, 1998).

Margolis and Romero (1998) further posit the ways that the hidden curriculum produces these professional norms through department culture, student cliques, and group interactions in meetings or seminars. Apple & King (1977) further recognized the deeply embedded nature of the hidden curriculum in seeking to preserve the existing social privilege interests and knowledge at the expenses of less powerful groups (p. 34). Essentially, as Quetzalli attests, she felt completely excluded from full participation, ultimately setting up students of color for failure in engineering pathways.

This study empowered these Indigenous engineering students to define phenomena for themselves, instead of others doing it for them. My findings here further complicate how these assimilationist structures condition Indigenous students to use dominant language in understanding how they are overcoming systemic racism and white supremacist environments. Furthermore, the following two subsections discuss the challenges students faced along their engineering journeys, to include racism and isolation and negative classroom experiences.

Racism and isolation. Four of the seven participants described experiences with racism, isolation, and in some cases, both. Experiences of isolation and cultural alienation can lead to self-doubt, depression, and dropping out (Woodford, 2005). These students described feeling alone and also felt disconnected from their families and their Native communities, as this was the first time they have been away from their families or another Native person in their life. These feelings of isolation are common among Native students in higher education and are pervasive in the current literature (Jackson et al., 2003; Poolaw, 2018; Lin Lin, LaCounte, & Eder, 1988; Shotton, 2008). Micah describes his challenging first year:

> So I had no friends, no anything…so I'd go to do to class and then come back and just go to sleep and not do anything because there was nothing to do. And I had no interest and I

> guess that kind of affected my classwork, and I had to withdraw from my chemistry class. I got a D in my math class, which is not like me to do. So I stayed another year and I was like, all right, I'm actually just do this.

Micah said he missed his family so much, especially when he would see Snapchat videos of his nieces and nephews growing up. He adds that "Natives are surrounded by family so much that when they're gone, they're like they miss their family and their family misses them."

Bree emphasized her shyness throughout her life having an effect on her having "three actual friends going through college." She leaned a lot on her parents for getting through college. Hank also describes himself as a "loner" and how that made finding connections with peers difficult, especially in engineering. He further describes his experience:

> You know, it's like you need folks in your class and stuff to kind of like group together to work on projects or to either bounce ideas off of for homework and things like that. It did take me awhile to kind of get established on that. So it's like, but most of my friends and stuff in AISES and everything, I never really would have classes with them and stuff like that.

Hank struggled with making connections within his major area. He even added that "with Natives and everything since there's not as many in any school, you know, it's like you don't necessarily have that like right off the bat, not in STEM or in engineering." Hank describes his isolating experience:

> So it's one of those things whenever you're in gen ed classes that you meet a lot more Natives. I kind of came across various folks in classes and everything, and that's how I got into the Native clubs and everything. Once you're in deep into your program in

> engineering there, you don't have that anymore. There's a little bit more on the loneliness and isolation by the time we get into junior and senior year. And by that point, I ended up doing the five-year program because I dropped a class that's only offered one semester… So people I knew they were now beyond me, and then I was back with the class younger than me – like that whole set of folks now who already know each other. So I had to find my way into various things.

Quetzalli discussed how she was called "wetback" and other derogatory names throughout her undergraduate experience and that racism was "present everywhere" and "it's the norm." She says she had to "develop a thick skin" to get past all of the racism and isolation. Since she was also a nontraditional student and a parent of two, she struggled to find study groups that could accommodate her schedule. Additionally, she talks further about trying to navigate her way:

> And I didn't know how everything worked. I was new. I didn't know that networking was important. I didn't know that there were students that had solutions to homework problems from last year and that's how they were able to make it. Even though I don't have the highest GPA, I am very proud that I didn't have to look at other homework to be able to understand or do my own homework. But I realized that if you were in a sorority or fraternity, you had access to those. And I was like, oh my goodness. Um, I'm a student, right? You're like, oh, that's how they… No wonder they have like… how did they get the homework solutions already? And if you're not a part of their circle then you're not going to get them.

Being away from family and in a new space with very few Indigenous people created many challenges for the participants. Not only is the coursework demanding, but Indigenous

students had to confront racist and isolating environments that seek to exclude them from fully participating at an equitable level as the white students. Furthermore, the very structure of not having equitable access to homework solutions and failing classes that set them behind an entire year, create a culture conducive of weeding out students of color. Indigenous students are accustomed to a communal culture, which is in contrast to the Westernized competitive and individualistic culture, particularly present in STEM fields (Geisinger & Raman, 2013; Seymour & Hewitt, 1997). Each one of these engineering students enacted survivance in the face of normative cultures of racism and in overcoming feelings of isolation. However, these white dominant "norms" need to be challenged and uprooted by the academy in order to create more welcoming and supportive spaces for Indigenous students to be successful.

Negative classroom experiences. All seven of the participants experienced negative interactions with faculty, had a negative experience with a class, or had issues adjusting their first year at the large, public institutions. Quetzalli experienced several negative interactions with faculty when she transitioned from a community college to her four-year public institution on the West coast. She tried to attend office hours to receive assistance with her homework, but her professor turned her away explaining that she needed to go to the TA for homework questions. However, she could not go to the TA's office hours with her work and family schedule. Another incident was when her son her son was having to attend speech therapy once a week and it conflicted with her professor's office hours. Quetzalli describes the moment:

> She's like Quetzalli, you need to learn to make choices, whether it's your career or whether it's your personal life. If you can't handle it… she said something stupid like... you need to decide whether you're going to strive for your career or are you going to strive for to take care of your son? And I was like, WHAT!? The instructor said I don't

> have time to accommodate students' needs, so do you need to make your choice; if you can't make it then you can't make it. You should consider dropping the class. And I ended up dropping the class because it was already four weeks – the fourth week – and I felt like I was falling behind. And I didn't want to be in a class or in a course where the instructor's mentality was like that. Like, I was scared... I was like, what if in the future I have an emergency and the instructor is going to be like, well you have to decide, is it your family or is it your career?

The lack of understanding for Indigenous student needs from faculty are frequent in engineering environments and are often described as "chilly" ones for students of color (Cabrera, Colbeck, & Terenzini, 2001). Additionally, for many of the participants, they struggled through challenging coursework in many different forms. For Marcus and Micah, they met some unforeseen challenges to enter into their respective engineering degree programs. Marcus describes his experience:

> I guess the biggest obstacle I have overcome was getting into the mechanical program. So when I first came in, I told you that it came in as an open option. And so I applied to get into the mechanical program here, but it's limited to a certain number of students. So I applied once and then due to one of my grades my freshman year, I wasn't able to get in. But over the summer, I was able to retake the class and I was able to get in. And that is what has really kept me here at [this institution]. I don't think I would have been as happy choosing a different major.

Micah had a similar experience trying to get into his optical engineering program. Due to a difficult first semester at his institution adjusting to the new environment, he did not get into

the optics program at first, which set him a year behind. Micah describes his summer after his failing grade:

> So that summer I got ahead in math, and that was a hard summer. I took calculus one and two in 10 weeks. That was summer '16. So after my, after my fall semester or after my my freshman year. And even then, like after that my credits would transfer but my GPA, those would stay unaffected. So my GPA was still like 2.6 or something and the next semester comes around and I do way better.

Micah was able to catch back up due to his dedication in taking coursework over the summer, and he said "my hard work paid off." Additionally, he took a 20-credit hour semester the following year of all math, science and optics classes to continue to make up for his first-semester difficulties.

Hank and Josefina also described challenging coursework and making bad grades for the first time in their lives. Hank noted that his Numerical Methods class was one he "passed by the skin of [his] teeth," and that he did not want to take the class again, particularly since many of these classes were only offered once a year. Bree also experienced a class her junior year in her major coursework where she actually had a passing grade, but the professor failed her. She was already immersed in her summer internship in Turkey that she could not dispute it until she returned, where she says:

> So I came back the next semester, talked to him. He's like, I failed you because you lacked passion and I think you should switch your degrees. I don't think you have the abilities. And so, I was like, I'm going to stay. But I didn't tell him that, I was just like

> okay. So usually when I get mad I just stop talking, so one word answers and I just said okay. And then I was back the next semester.

Bree struggled with the confusion of this professor's decision to fail her due to "lack of passion." She added that she was confused as to why she was pinpointed here and asserted that she "didn't do anything different than anyone else," and that it was "all whiter kids or whiter dudes in chemical engineering with [her]."

These interactions could have easily caused each of the engineering students to drop out of their major, and maybe even school altogether. However, they stayed the course beyond these negative classroom experiences, and experiences with isolation and racism. Their use of survivance to keep going in their engineering major pathways beyond these systemically unjust pressures made them successful. While survivance was found to be useful in their persistence, the right amount of institutional and peer support is necessary as a part of their building community on these non-Native institutional campuses. The responsibility falls on the institution and its administrators to create environments that not only provide access but continued support throughout their collegiate experiences.

Building a "School Family" or Community

The third lesson focuses on the participants' avenues for finding support throughout their undergraduate engineering journeys. All of these support networks were centered around relationships. While being away from home, students had to be connected with what Hank called his "school family." These include keeping in touch with supportive family, Native support programs, and faculty relationships.

Family. Numerous scholars have noted family support and encouragement as a key factor in Native students' persistence in higher education (Benjamin, Chambers, & Reiterman, 2010; Chow-Garcia, 2016; Guillory & Wolverton, 2008; HeavyRunner & DeCelles, 2002; Jackson et al., 2003; Larimore & McClellan, 2005; Lee et al., 2010; Lundberg, 2007; Pewewardy & Frey, 2004; Waterman, 2012). Six of the seven participants expressed that support from at least one parent, or other family members, were integral to their persistence. Bree emphasized her parents as being her main support through her chemical engineering program:

> They never required me to have a job through college, so I could put all of my focuses on schoolwork or something. And then just, you know, having multiple breakdowns all the time throughout engineering [laughing], my mom and dad's always on the phone, like, "calm down, it's going to be okay. You're not dying."

Josefina echoed Bree's sentiments in attributing her parents as being her main cheerleaders. She did state that "sometimes they pushed me a little hard." However, that was just the motivation she needed to keep going, and they kept reiterating that she was going to love this major. Hank mentioned that his campus being close to home allowed him to make trips to see family for support when necessary. Xander attributes his mother to his motivation for pursuing higher education and for persisting, as seeing her finish her degree growing up really inspired him. As a single mother, Micah's mom took care of him and his older siblings since he was about three years old. He states that "it's just amazing how she can raise all of us and take care of…make sure we're doing good and every single time since pretty much my whole life, when I've needed her the most." As for Quetzalli, though she did not have the parental support through her undergraduate experience, she did lean on her children as motivation and support for her persisting. Her grandfather also played a key role in her success. Her brother has also assisted her

in moving, and now her mother has come full circle in graduate school supporting her. Quetzalli shares her thoughts in reminiscing on her success thus far:

> I think my inspiration came from my grandfather… especially from my grandfather. That man is as [her tribal nation] as you can get. The way he talked about Mother Earth. The way he talked about who we were before colonialism came. The way he talked about our traditions and how we continue to do some of them, but hidden under the Catholic religion. The way – even him – he was doubtful. He said you shouldn't go to school, you need to be a housewife. But now he's so proud of me, and he just, he can't believe it sometimes. My daughter has definitely been my inspiration because I did not… I want to set an example that she can be more than just a housewife because that's what we're trained to be. She was really my motivation to continue so that I can provide for her later and show her that we can get an education. My children I guess, right? Because my son came after. And during the undergrad it was my supervisor, who taught me who I am and to remember that I am [this tribe], and that I'm unique because I'm the only [person of this tribe] in the engineering program. And I was like, yeah, you're right! And after seeing and understanding the education system, I think that there's still a lot of work to do. And I want to contribute to that – as an engineer, as a tenured faculty one day – I'm going to contribute to that. And it's an invisible problem, right? It's an invisible problem because people from our own community don't realize it's a problem – until you go through it, until you experience it. You realize, how did I make it and why did so many others not make it. How did I make it with two kids and the other person didn't make it? Why did they drop out?

Native support programs. For all of the participants, they noted Native cultural centers, AISES or SACNAS, and multicultural programs as key support networks throughout their programs. The participants were able to connect with Native faculty, staff and peers in being involved in Native support programs. Numerous scholars have reported that Native American clubs, multicultural centers, and peer mentors are key to persistence for Native students (Brown & Robinson-Kurpius, 1997; Guillory & Wolverton, 2008; Lundberg, 2014; Lundberg & Lowe, 2016; Mendez et al., 2011; Shotton et al., 2007; Shotton et al., 2013). An additional component was either continued connection to culture or a reconnection with culture for those who did not grow up traditional. Josefina and Marcus discuss their engagement with a president's multicultural advisory council, as well as with their campus' Native cultural center. Josefina specifically centered on the ways she has been able to reconnect with her culture through the center:

> I mean, I guess one thing has been a women's circle and learning how to bead and I've always wanted to bead because our family friend's grandmother was constantly beading throughout my childhood at the front desk and all of her works were gorgeous. And I was like, "oh, I want to do that". But even my parents didn't know, so I'm really glad I'm able to get into that now.

Marcus consistently discussed his early connection with his campus' Native cultural center, and how that center has been instrumental in his finding community. Marcus credits the Native center at his institution for providing him resources, such as tutoring, and other levels of support. He shares his experience and advice:

> Find a community of people who will help you. The Native cultural center office really helped me in that first semester I was here. Just the tutoring I was able to get from them...the different support that we had. Just other people to talk to you about struggling through school. Attend office hours. Literally go to any resource that will help you. You know, it was one of my biggest issues my first semester. I was just not willing to find other resources that would help me.

Bree also noted how AISES assisted in her gaining some supportive friends and a cultural connection:

> AISES was a big one that I was in. I was in there for five years I think five or six years of college. I gained a lot of cultural experience that I lacked growing up just because of the, just, I wasn't exposed to it ever and I couldn't really find that place to get my family to find it or revitalize it or something. And I could find it in AISES or AISA. That was really, that was really good for me. I know because I never had any kind of background with my culture.

While involved in AISES attending conferences, Bree was able to connect with peers, and gain internship opportunities. Micah additionally noted the connection to peers and professional development in both AISES and SACNAS. He describes the benefits of these organizations:

> What I've gained [from AISES] is connections – friends. I have gained a couple friends from being at the meetings. Just time to socialize with non-engineering students where you can talk about video games or just things coming out, or if you want to go watch the game, or do you want to go do this. I can't wait to do SACNAS because of the conference in San Antonio, and the conference in Hawaii, hopefully. That would be the best. That’s

> what I've gained from it. But from both of them combined, it's kind of talking professionally is what I've gained. But like even now where you need to talk about yourself or how you got to where you are or what you learned or what you gained, things like that. It's really good that those kinds of things where you talk about yourself is good in the long run.

As for Hank, he primarily established his community through AISES, his institution's Native support office, and the multicultural engineering program office. Hank was able to obtain internships and present his undergraduate research at AISES conferences, and found supportive staff in each of these spaces, to include his AISES advisor, the multicultural engineering program director, and the Native support office's director. He attests to his experience trying to build his community:

> But also, in going to my institution in terms of Native everything, I knew that there was a decent amount of folks that were Native here. If you go to a place that is like more, more I guess, predominantly white, students try your best to find other Native folks. You know, you so hate to say it, but sometimes you have to be the one that seeks them out, you know? You have to be the one that seeks them out because a lot of Native folks, you know… by the time we get to this point, you are a bit of a loner. It's like you're going to have to kind of just want to stick alone. You almost have to be the one that reaches out to other folks. Or maybe you're not trying to find other Natives but just you have to be the one that sometimes builds your support system.

For Hank, he had to step outside of his comfort zone to seek out a support system, particularly outside of the engineering department. He knew his public institution already had a decent size

Native population, so that also aided in his decision to attend his institution, and start seeking out those spaces, though he admits he is more of a "loner."

While Xander also found his support community primarily with AISES, he had found out about AISES during his tribal college years before he came to his current four-year, public institution. Since then, he has taken on the presidential role and actively recruited members, increasing their numbers of students attending the AISES conferences and obtaining internships.

Faculty relationships. For three of the participants, key faculty members were instrumental in their connecting with engineering and persisting through. Many of the professors mentioned by the students believed in their abilities and often connected them with further professional development opportunities, such as working in labs or undergraduate research projects. Strayhorn's (2012) study of STEM students of color found that sense of belonging in STEM is particularly important for minoritized students "who face unique challenges in establishing such connections in fields where they are 'one of very few' to quote a student" (p. 66). More specifically, Strayhorn (2012) found that faculty member behaviors contributed to students' feeling of mattering and that they knew their name, demonstrated an interest in their degree or professional goals, and seemed to care about their mastery of STEM course content" (p. 69). Xander mentioned two of his faculty members being instrumental in his motivation to persist. He describes them both:

> And I loved having both of them because I can actually sit down and talk to them, and they spoke to me like an actual basic human being. You know, they don't make stuff super complicated, and if I give them that look that I'm having trouble, they actually would simplify it.

Xander's professors took time to work with him on problems he did not understand. Likewise, after Micah had his challenging first year, once he bounced back and brought his GPA back up, he was able to obtain an internship with a professor in his optics program. He was able to work in his lab over the summer, where he met his friend of his same tribal affiliation.

Hank emphasized a mechanical engineering professor who asked him to conduct undergraduate research with him. Hank noted that in addition to being a wonderful supervisor, that this professor went above and beyond in giving "good advice on things," and taking him to lunch. All of these professors provided an essential link to experiential learning opportunities, but also to providing a sense of belonging for each of these students.

For all of the participants, finding a "school family" was and continues to be a motivator for persisting in their programs. While this may come in various forms for each of the participants, they were each able to build their community within Indigenous organizations and a combination of building relationships with faculty and peers in their disciplines. AISES and SACNAS provided a unique space where the participants could be around other Natives in the STEM fields, and not have to compartmentalize one or the other.

Establishing Confidence through Experiential Learning

While the final lesson relates to the students' supportive connections previously mentioned, this section primarily discusses how the students established *self-efficacy*. Self-efficacy is defined as "people's judgment of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1982, p. 391). Furthermore, research has shown the link between self-efficacy and students' choices to pursue and persist in engineering (Bandura, 1997; Pajares, 1996). While their support through family,

Native support programs and discipline-specific organizations provided a gateway to these opportunities, the experiential learning coupled with their support systems established the confidence in their own abilities, as well as socializing them into the engineering profession. The students were able to understand the applicability of what they were learning in classes through hands-on experiences. These experiential learning activities include internships or other work experiences, and research and lab opportunities.

Internships or other work experiences. Through student organization involvement in AISES or SACNAS, all of the students were exposed to industry professionals in one way or another. Additionally, a couple of the students worked on campus in capacities that gave them hands-on experience in the engineering field. Quetzalli's first job during her undergraduate years was as a part of research center's academic outreach program, where she served as coordinating tutor supervising math tutors who "provided tutoring services to underserved communities." During this experience, Quetzalli notes how she became aware of the harsh realities of the many local schools who were severely underresourced, especially in contrast to her schooling experience. She expressed that the job "opened my eyes to an even bigger problem in our community and our education system," but that this job became a "home away from home." Through this experience, she also learned about the NSF proposal process as a valuable resource for helping communities, as she served as a liaison between several engineering departments and the community. She describes her experience:

> And I realized, oh my goodness, I can do a lot more with a Ph.D. if these guys can do this, I can do a LOT more because I know where those resources can go. And I know how to help my community. And at the same time, I have a foot in the door in the technical field. And so, that was really what motivated me to come back to the university.

> I didn't even know that engineering education existed. I didn't know that that was an option, and it helped to be an engineer already. [laughing] It helps to have that background and understanding of the curriculum or exposed to the curriculum and exposed to the pathways, right? To obtain and finish an engineering degree.

In addition to Quetzalli's experiences, Xander obtained a full-time position in the Information Technology department at his current four-year, public institution. This job aided in his decision of which engineering major to settle on, in addition to the fact that he had many core requirements completed already for electrical engineering. During his years at the two different tribal colleges, Xander experienced an internship with NASA thanks to an AISES tribal college undergraduate program. His current work experience has led to his ambitions of finding a post-college job as a "network engineer." As for Hank, he interned at GE his first two summers in college that he obtained through attending AISES conferences. These experiences gave him an insight into the field early on that increased his sense of belonging in the engineering field. Bree also received an internship offer from BP and worked with them in Alaska one summer. She says how attending AISES conferences was a "game changer." For Marcus and Josefina, they have not yet had internship experiences. Josefina just secured one for this summer at an aerospace company with her end goal being to work at NASA and use her skills for "research and space exploration."

Research and lab opportunities. As a part of their engineering curriculum, all of the students participated in labs or undergraduate research that were instrumental to continuing to nurture their fascination with their respective engineering pathways. Additionally, some participated in more formal undergraduate research opportunities that influenced their career trajectories. In the summer of 2016, Bree had a chance to conduct research on honeybees for the

National Science Foundation in Istanbul and Ankara, Turkey. Hank emphasized his undergraduate research experience as being fundamental to his persistence and finding belonging in the field. His junior year, he became a scholar for a Ph.D. pipeline program for students of color that initially sparked his interest in undergraduate research. Due to his good relationship with one of his mechanical engineering professors, who was also his academic advisor, he was offered a chance to conduct research with him over the summer, which led to a continued gig throughout the rest of his undergraduate experience. The undergraduate research experience led to his interest in pursuing his graduate studies. Hank states that the undergraduate research kept him "personally invested in things." He continues to say that:

> … you're seeing what all your classwork is trying to build towards or whatever. If you wanted to do the advanced education and things like that, that's the type of stuff that you were looking at. So it was like, there wouldn't be anything that you necessarily see in a class, but you'd have to go out and do outside research and things of that nature. So it was like, yeah, everything that you're learning in undergrad is the basics for everything, but then like the more advanced things, the more applied things, that stuff that you'd see on the job or in research.

As for Josefina, she really established aerospace engineering as her career pathway when she could apply what she was learning in a lab. She describes the experience:

> Throughout my three years here at school as I've learned all the skills that engineers need to go into the field, I've loved it. Like material science – learning how to manipulate metals, this and that, to get them to do whatever you want them to do. That. I love that. Our labs have been really fun. Like we had not a workshop, but kind of a workshop lab where we learn material science, the science of materials, and then the workshop lab was

> when you actually got the metal and the wood and the big machinery and cut them and shape them and this and that. The fun part was where you actually get to like build things. So yeah, I really loved it ever since.

Josefina attributes her labs as being the most impactful experience to her persistence. She notes that they were reassuring in that she could "actually learn and improve [her] skills." Josefina is currently working on a satellite project with some other AISES peers, which excites her.

Micah also discussed many of his research and lab experiences throughout our conversation. His first experience in the summer 2017 was a research internship in his College of Optics where he "tested what's called a confocal microscope." He ended up entering the same internship program again the following summer, where he met his Native peer, who invited him to join his research team on a project. This same project was recently accepted for publication, and he was able to share that breaking news of the acceptance with me during our conversation. His experience in the hellography lab led to a continued job throughout the school year, which he noted was his most impactful experience on his persistence.

Xander's experience with undergraduate research began at his tribal college, when he participated in an REU (Research Experience for Undergraduates) at four-year, public institution in the Southwest in their optics department. Xander noted that he worked with lasers and "four-way mixing and learning how to take a signal and make it stronger and sharpen it" during this summer there. Additionally, he spoke extensively how he connected with many peers, which aided in his feelings of belonging and socialization into the engineering field.

Six of the seven engineering students discussed some form of experiential learning as influential on their finding belonging and persisting in their engineering programs. This last

lesson affirmed the students' desires to stick with engineering after the impact of these experiential learning opportunities. They could actually see their coursework come to life, and this encouraged their persistence over obstacles and other failures along the way. While Marcus was the only student to not indicate experiential learning as a major impact, he stated that he is hoping to get his first internship experience this summer and that his goal is to work in the aerospace industry where he can be "working hands-on with something, designing projects."

Maintaining Cultural Identity to Achieve Utiyvhi (Balance)

A common thread throughout the participants' experiences in their undergraduate programs was maintaining or nurturing their connections to their culture. Additionally, each of the participants had various ways of wanting to give back to their communities. According to Byars-Winston et al.'s (2010) study with African American, South East Asian, Latino/a and Native (ALANA) science and engineering students, participating in racially and ethnically affirming "counterspaces" reinforced ALANA students' sense of cultural identity and helped to combat negative campus climate experiences. Having their identity at the core of their experience really strengthened their motivation to persist, eventually leading to a newfound understanding of their identities being key to their success in the engineering field. As symbolized by the sacred fire in Figure 5.1, their Indigenous cultural identities provided strength and unity connecting each of the seven engineering students. Micah recalls a quote that resonated with him from a SACNAS conference and how it reenergized him:

> I went to the SACNAS conference with a friend and they said something like "it's like my background is the reason why I'm so successful in this field." And you know, being [southwestern tribal affiliation] and having this kind of experience where I have my grandma's house or living on the rez living with no water or something. It's like, I feel

> like it does give me and [my Native peer] some sort of edge to problem solving and a different viewpoint. I mean, it's that plus like, you know, just being smart. But we were both able to record holograms a different way which was more efficient, and we were able to get a really clear image when you look through the heads up display.

Micah goes on to explain how his experience has led him to participate in outreach through giving lab tours to Indigenous and Latino/a/x students. He states that the director of the program told him and his Native peer that "when it's you two, their faces light up and they're really interested."

For Josefina, she countered feelings of not belonging with a different outlook:

> That's not me to be like, "wow, I'm kind of the only minority here. Maybe this isn't for me". I've always seen it as like, "I'm the only minority here. I need to be here. Like I have to be here." If it's not me, then it might not be anybody else. Or if it's not me, it might only be one other person. Like I'd rather kind of go down that path even if it's not well explored, than just try and be like, oh, these people aren't like me maybe I shouldn't be here. Yeah. I don't know. I've always tried to use that as like motivation to stay in my degree.

Josefina viewed her being one of the few Indigenous students in aerospace engineering as empowering. Additionally, Josefina volunteered at a Native American STEM Institute that her campus hosted, where she spent an entire week with students from the local urban area and surrounding reservation communities. This experience was transformative for Josefina in exposing her to the realities of inequities in school opportunities. Her advice is to "Be your own hero."

Quetzalli leaned on her spirituality and attending ceremonies to reenergize her. She stated that she's "learned to bring in [her] culture and to appreciate [her] culture and to be proud of [her] culture." She also worked with a program that created opportunities for students of color in K-12 that opened her eyes to the inequities in school experiences. Furthermore, her supervisor reminded her of who she is as an Indigenous person and that she was the only person of her tribal background in the engineering program. She further describes her newfound understanding after her experience as a coordinating tutor for an outreach program that provided tutoring services to underserved communities:

> And after seeing and understanding the education system, I think that there's still a lot of work to do. And I want to contribute to that – as an engineer, as a tenured faculty one day – I'm going to contribute to that. And it's an invisible problem, right? It's an invisible problem because people from our own community don't realize it's a problem – until you go through it, until you experience it. You realize, how did I make it and why did so many others not make it. How did I make it with two kids and the other person didn't make it? Why did they drop out?

Quetzalli expressed the importance of her being on this engineering pathway so that she can "be that person that wasn't there for me" and "someone that looks like them." She adds that she "wants to be proof that it is possible" because with "education come a lot of power." Furthermore, she emphasizes the importance of access and knowledge of grant writing so that she can eventually help her community. Brayboy (2006) identifies *power* as "the ability to survive rooted in the capacity to adapt to changing landscapes, times, ideas, circumstances, and situations" (p. 435). While Quetzalli has recognized the power that comes with education, she is

also utilizing a form of power as her resistance leads to her motivation for persisting through hostile conditions in the academy. Deloria (1970) argued this decades ago as he asserted that ‘‘few members of racial minority groups have realized that inherent in their peculiar experience on this continent is hidden the basic recognition of their power and sovereignty’’ (p. 115).

For Hank, he also relied on his Native fraternity, AISES, and his spirituality to assist in his persistence. For Bree, Marcus and Xander, they were able to forge stronger connections to their cultural identities through AISES and Native support programs. Now that Bree is in industry, she is working to get her company involved in supporting and recruiting at AISES conferences. Xander revived the AISES chapter at his institution and it became his mission to help other Natives find internship opportunities. Overall, each of the participants found that through connecting with their communities in their own ways, whether that be through AISES and/or institutional Native student support programs, they were able to strengthen their Indigenous identity has a core part of finding their place in engineering.

Deyhle’s (1995) work on cultural integrity highlights that in order to for Indigenous people to be successful in the academy, they must maintain a strong sense of their Indigenous identity as distinctive and as a source of pride. However, as TribalCrit notes, the concern is still on the assimilationist efforts of Westernized institutions and spaces in replacing Indigenous knowledge with academic knowledge (Brayboy, 2006). However, the students in this study were able to find their own counterspaces on their respective campuses both in the form of Native organizations and support programs, and through engaging in their cultural spiritual practices. Through these mechanisms of maintaining a strong cultural identity as an Indigenous person, as well as participating in outreach, the cycle comes full circle to positively influence future generations of Indigenous students considering engineering as a potential pathway. The students

are able to see other Native role models succeeding in these fields, which have the potential to alter their future career pathways.

Summary of Findings

This chapter highlighted four lessons gained from the shared stories of experiences of these seven engineering students. Brayboy (2006) asserts that "stories often are the guardians of cumulative knowledges that hold a place in the psyches of the group members, memories of tradition, and reflections on power" (p. 440). Furthermore, the numbers four and seven are sacred in Cherokee culture and appear repeatedly in myths, stories and ceremonies. In my study, the two numbers appeared in the form of lessons and the seven engineering students, which naturally forged together in a relational manner that allowed us to co-construct the Utiyvhi in Engineering model. The four lessons included how participants' gained access to engineering, their use of survivance in overcoming challenges on their engineering journeys, the key support networks that embodied their "school family," and the experiential learning activities that aided in building their confidence in the engineering profession. Additionally, the core component of maintaining their attachment to their Indigeneity provided them strength and unity to persist. The final chapter will include a discussion of findings using an Indigenous research paradigm and TribalCrit lens, the study's major contributions to the literature, and implications for future policy, practice and research.

Chapter Sudali (Six): Discussion & Implications for Policy and Practice

Creating Utiyvhi (Balance) for Indigenous Persistence in Engineering

This final chapter merges the co-constructed Indigenous knowledge from both I (as the Indigenous researcher) and the seven Indigenous engineering students' stories to provide insight to higher education administrators at non-Native institutions, as well as to provide hope for future generations of Indigenous students considering pursuing engineering as a career pathway. This lays the foundation for how we continue to move forward to seek Utiyvhi (balance) for our Indigenous students pursuing engineering pathways at NNCUs. Engineering careers, particularly those that benefit tribal communities directly, have the potential to improve the livelihood of Indigenous peoples and our tribal nations, which also affects the quality of life for our nation as a whole. The new knowledge and problem-solving skills gained can improve environmental protection, natural resource development and infrastructure – through telecommunications, broadband and electrical services, housing, roadways, bridges, sewers, public buildings, and solid waste treatment and disposal – for tribal nations. In essence, engineering careers can increase tribal sovereignty efforts by providing the skills and knowledge to tribal citizens to enhance the health, safety, and welfare of its citizens within their own tribal territories. Consequently, understanding Indigenous student stories of survival and persistence at NNCUs is extremely valuable to increasing Indigenous participation in engineering fields. This study is able to provide a road map for NNCU leadership to understand various support structures and early childhood experiences that are important in attracting and graduating Indigenous students to engineering pathways.

Reflections on the Research Process

Throughout this process, I not only found direction in my research topic, but I have continuously sought to decolonize my own paradigm as a white-passing Indigenous woman who grew up away from her tribal community and traditions. As I did not begin to engage with my tribal nation fully until I was 18, it has been a constant process of unlearning dominant paradigms to view myself in relation to all beings and to learn how to relate tribal teachings to my academic work in a westernized academy. Like many nontraditional Indigenous people and a few in my study, we are working to learn our languages, our traditions, and engage more with our culture through programs offered through our nations and institutions of higher education. We are living in two worlds and trying to balance both of them to survive and thrive for our communities, to honor our ancestors, and to positively influence future generations of Native students entering these institutions. Furthermore, feeling confident in my Indigenous way of researching outside of the academy's "rules" has been a decolonizing process. Through many Indigenous scholars previous work (Archibald, 2008; Smith, 1999; Poolaw, 2018; Tachine, 2015; Shotton, 2008; Wilson, 2008) utilizing their own tribal epistemologies and Indigenous methodologies and frameworks, I am able to stand on their shoulders in a growing community of scholars dedicated to privileging and validating Indigenous research. It is my hope that through my research agenda and methods, I have done justice for my people through engaging in this Indigenous paradigm shift that emphasizes Indigenous knowledges and values. Throughout this process, I also have reached Utiyvhi (balance) in my mind, body, and spirit.

Engaging in conversations with these seven engineering students made me question why I had not pursued engineering as a career path when I excelled in math and science? Or rather, "Why had no one even mentioned engineering as a potential pathway for me?" Finding my epistemological stance through Indigenous frameworks including the Tsalagi (Cherokee) concept

of Utiyvhi and Storywork, I recognized the lesson of centering my study on the experiences of Indigenous engineering students and graduates. This realization brought me full circle to my overarching research question: What are the experiences of Indigenous students persisting in undergraduate engineering programs at four-year, public NNCUs? Through the lenses of Brayboy's (2005) Tribal Critical Race Theory to Wilson's (2008) Indigenous research paradigm and focus on "relational accountability," the research questions were developed with a critical and relational focus on the institutional influence of the participants' experiences. While the overarching research question focused on the Indigenous engineering students' experiences through story, the first sub-question delved into their pre-collegiate pathways that led them to pursue higher education and their engineering majors. The second sub-question uncovered important support structures that encouraged their persistence in their engineering majors, while the third question sought to guide administrators on actions to take to provide such supportive and nurturing environments that are unique to Indigenous engineering students. The final sub-question addressed how students are able to "give back" to their tribal communities through engineering degree pathways, which offers insight to administrators on strategies they can work to improve tribal nation sovereignty. As a reminder, the sub-questions were as follows:

1. What were the students' pre-collegiate pathways to pursuing an engineering degree?
2. What is motivating and supporting Indigenous students to persist in engineering majors at four-year, public non-Native institutions?
3. How can these lived experiences guide how we as student affairs professionals can better create a supportive community for our Indigenous students in engineering programs?
4. How can we work to promote engineering careers for the betterment of tribal communities and sovereignty?

Now coming full circle after thinking through the seven engineering students' stories, I have learned so much from their individual and collective voices. In an attempt to honor their narratives, I worked to share their stories in an authentic manner avoiding explicit researcher analysis. From their inspiring and powerful stories shared about their experiences, it is my hope that the reader understands the urgency of these lessons that have influenced their engineering pathways. They have persisted on in this field at a non-Native institution, and it is important for higher education administrators to understand how they have done so.

From a researcher perspective, I have been transformed through this process as I gained so much insight from the engineering students' stories. As I read and re-read through their transcriptions, I paused to ask critical questions of the data and myself to guide me through this research pathway. As I do not take this research lightly, I was hard on myself to do justice by their stories to come up with thoughtful and critical lessons to offer guiding points for administrators and tribal communities. Consequently, I continued to reflect upon my conceptual frameworks, my research questions, and the literature in search of a model for organizing the individual stories and collective findings. As a result, the four lessons were born and that directed me toward the Tsalagi (Cherokee) concept of Utiyvhi (balance) to construct the Utiyvhi in Engineering model, utilizing symbolism and teachings from my tribal nation. We were able to co-create a model as our stories (I, as the researcher, and the participants) intersect to forge hope for future generations to come.

Consequently, this final chapter provides Utiyvhi (balance) as this study comes full circle with discussion and future implications of the collective findings are shared. This chapter begins with a summary of chapter five's findings and the four lessons discussed. It then circulates through a discussion of the study's conclusions through Tribal Critical Race Theory and

Indigenous Research Paradigm lenses. Paired together, these lenses allow for an analysis of the systemic and structural forces that impair Indigenous engineering degree attainment. Furthermore, these lenses highlight Indigenous paradigms in empowering our tribal communities and privileging our ways of knowing and being. Lastly, this chapter presents the study's contributions to the literature and its implications for practice, policy, and research.

Revisiting the Four Lessons from Indigenous Students' Stories

The seven engineering students in this study had unique experiences to share that led to their varied pathways through persisting in their engineering programs. The first lesson was nurturing an early connection to engineering, beginning in their early childhood years and showcased how their connection to STEM, and later engineering, was nurtured. While the majority of the participants' parents had obtained college degrees, even for those who did not, they were encouraging of their child's pursuit of higher education. Additionally, as an early fascination of STEM occurred at an early age, parents and teachers were instrumental in continuing to nurture this fascination through their K-12 education, leading to their math and science exposure and preparation. For a couple of the students, they were able to attend satellite schools to gain access to advanced levels of math and science. Mentor influence in the form of a teacher, counselor, former student, or parent, influenced each of the engineering students' pathways to engineering. One way or another, each of the participants were exposed to positive role models who were practicing engineers or encouraged their pursuit of the profession. By time students were applying to college, they had an idea of which engineering major pathway they wanted to pursue and were more prepared due to their math and science preparation, as well as their parents' and/or other mentors' encouragement and expectation of their attending college. Furthermore, because college was visible in their lives from an early age, this aided in the

students' matriculation to college and college choice. Proximity to home was important for most of the students, while other factors such as programmatic offerings and relevant cultural messaging made a difference as well. For the two nontraditional students, they experienced hostility from their high school counselors in attempting to "track" them to trade schools over college. Fortunately, they both turned down the advice and matriculated to two-year colleges before transferring to their four-year, public, non-Native institutions.

The second lesson was utilizing survivance to conquer the hidden curriculum. This lesson moved through the participants' experiences through their engineering journeys at their respective four-year, public non-Native institutions. The seven engineering students utilized survivance to overcome serious systematic challenges, such as racism and isolation, as well as negative classroom experiences. Negative classroom experiences included challenging coursework and difficult faculty members, which often led to bad grades and setbacks in their completing their degrees or entering their engineering programs. Quetzalli described the hidden curriculum as the dominant group's way to maintain power in this profession, through sharing of past class notes and exams. She notates it as "playing a game" to be successful in these engineering majors. Consequently, much of this game-playing at these colonial institutions would lead to feelings of isolation. Many of the participants experienced feelings of isolation as they transitioned to their institutions, and in struggling to find peer groups. These feelings of isolation are common among Native students in higher education (Buckley, 1997; Henning, 1999; Jackson et al., 2003; Poolaw, 2018; Shotton, 2008), and can become amplified in engineering spaces where even less Native students are present. Often times, NNCUs are described as producing a "chilly campus climate" for students of color in STEM, specifically in the classroom, which has been linked to their attrition in these fields (Cabrera, Colbeck, &

Terenzini, 2001). When sharing stories of negative experiences, all participants experienced racism, isolation, or both. All of the students engaged with hostile environments that could have easily caused them to drop out or switch majors.

The third lesson was building a "school family" or community and focused on the participants' avenues for finding support throughout their undergraduate engineering experiences. The aforementioned challenges participants faced during their engineering journeys are important factors to consider when turning to identify factors that led to their persistence. How students built their "school family," as Hank coined it, was through family support, Native support programs, and faculty relationships. As noted previously, family support is a key factor in Native students' persistence in higher education (Benjamin, Chambers, & Reiterman, 2010; Chow-Garcia, 2016; Guillory & Wolverton, 2008; HeavyRunner & DeCelles, 2002; Jackson et al., 2003; Larimore & McClellan, 2005; Lee et al., 2010; Lundberg, 2007; Pewewardy & Frey, 2004; Waterman, 2012). Most of the participants noted the support of their parents, grandparents, or their children as being integral to their persistence in their respective engineering programs. Additionally, students found their community on campus through organizations such as AISES, SACNAS, Native cultural centers or other Native organizations, and/or multicultural programs. Often times, students were also able to not only gain peer support, but also financial support through these organizations and programs, which encouraged their persistence. Lastly, faculty relationships were instrumental in increasing their social capital in the engineering profession through research and lab experiences and professional development opportunities.

All of their research and professional development opportunities in engineering led to the fourth lesson of establishing confidence in their respective engineering disciplines. These experiential learning components attributed to their self-efficacy in their field, as well as

providing additional financial assistance. Research has shown the link between self-efficacy and students' choices to pursue and persist in engineering (Bandura, 1997; Pajares, 1996). Additionally, for all of the participants, maintaining or nurturing their cultural identity as Indigenous people and citizens of tribal nations throughout their undergraduate experience positively impacted their persistence in their engineering disciplines. Embodying a strong sense of cultural identity as integral to Native student success has been noted by several scholars (Brayboy, 2005; Chow-Garcia, 2016; Deyhle, 1995; Huffman, 2001; Jackson & Smith, 2001; Kirkness & Barnhardt, 1991; Tachine, 2015; Waterman, 2007). The students in this study recognized the Indigenous knowledge that they bring as making them better engineers and problem solvers. Being one of the few Indigenous students in their programs motivated them to remain dedicated to their majors as a way to influence future generations of Native students to pursue these pathways.

Discussion

In thinking through the rich stories of resilience and resistance these seven engineering students were willing to share, I came to the realization that NNCUs must look introspectively at the core of their engineering programs that create hostile environments for Indigenous students. The departments must not look at how Indigenous students must always assimilate or "play the game" in order to survive in these programs, but that they must do the work to create welcoming and inclusive environments that adjust to Indigenous student needs and epistemologies – if they truly want to recruit and graduate Indigenous engineers. Consequently, I will now further discuss the findings through the lenses of my two conceptual frameworks of Brayboy's (2006) Tribal Critical Race Theory (TribalCrit) and Wilson's (2008) Indigenous Research Paradigm.

Tribal critical race theory. Brayboy (2006) emphasizes that TribalCrit challenges structural systems and institutions to expose inconsistencies in an effort to create better experiences for Indigenous students. Furthermore, Brayboy (2006) argues for the blending of Indigenous and academic knowledges as a powerful key to survival. Each of the seven engineering students discovered avenues to either connect with their Indigeneity while at their campuses, or continued to nurture their mind, body, and spirit to find Utiyvhi (balance) through on- or off-campus engagement with their community. Their Indigenous cultural identity was at the epicenter of providing balance throughout their undergraduate experiences. All of the students noted how this gave them a sense of pride and further motivated them to pursue engineering majors where they were one of a few in their respective programs.

TribalCrit acknowledges the unique perspectives, experiences, and dual statuses of American Indian people, and is rooted in Indigenous ontologies and epistemologies (Brayboy, 2006). While TribalCrit offers nine tenets described in Chapter two, its basic premise is that of colonization being endemic to society. What Brayboy meant by this is that Western or Eurocentric ways of knowing and thinking have been imposed as the dominant paradigms and power structures throughout American society. Historically, systems of education have served as vehicles for achieving colonization, and these foundational values continue to wreak havoc on Indigenous students on college campuses (Minthorn & Nelson, 2018). Brayboy (2006) asserts that "colonization has been so complete that even many American Indians fail to recognize that we are taking up colonialist ideas when we fail to express ourselves in ways that may challenge dominant society's ideas about who and what we are supposed to be within the larger population" (p. 431).

In this study, the students experienced the effects of colonization in their undergraduate engineering programs. As Quetzalli described, the "hidden curriculum" was ubiquitous, and she learned how there were unwritten rules about getting through some of the tough engineering classes. The racism Quetzalli and Micah discussed was the "norm," and they were expected to have to deal with it in overt and covert ways throughout their undergraduate experiences in order to survive. The overrepresentation of men, particularly white men in engineering majors, should be a clear indicator of the patriarchal and colonialist nature of engineering program culture and curriculum at non-Native institutions. TribalCrit's first tenet of colonization as endemic to society is reflected in the expectation of the students in this study having to conform to the norms of the academy in order to survive challenging coursework and gain entry into their respective engineering programs. Even in Bree's case with the white male professor who chose to fail her for a class for the sheer reason of her "lack of passion," displays the political obstacles students have to face in order to pass classes. Quetzalli experienced something similar when she ran into professors not understanding her responsibilities as an Indigenous mother, thus causing her to drop classes and take extra time to complete her degree. These systemic issues in the academy, and particularly in engineering programs, create a hostile and isolating environment. Smith (2012) gives a powerful overview of the foundation of colonial universities:

> Although colonial universities saw themselves as being part of an international community and inheritors of a legacy of Western knowledge, they were also apart of the historical processes of imperialism. They were established as an essential part of the colonizing process, a bastion of civilization and a sign that a colony and its settlers had 'grown up.' Attempts to 'indigenize' colonial academic institutions and/or individual disciplines within them have been fraught with major struggles over what counts as

> knowledge, as language, as literature, as curriculum and as the role of intellectuals, and over the critical function of the concept of academic freedom. (p. 68)

However, like Shotton (2008) found in her study with Indigenous women doctoral students, the seven engineering students exercised decolonization efforts in the form of resistance to the norms of the academy. One major finding in this study is that the students found their cultural identity to serve as strength and motivation for their persistence in engineering programs. Quetzalli exhibited this through her not receiving past homework solutions from peers, but rather finding out she figured out the correct solution all on her own. Josefina and Micah noted their Indigeneity as being the reason for their success and solving problems through a different lens. Maintaining their cultural integrity through their beliefs, practices, traditions, ceremonies, and knowledge as tribal people was an integral part of their staying motivated throughout their education. For the students who did not necessarily grow up knowing their traditions and practices, they found ways to learn through Native program involvement. Findings from this study with regard to colonization and resisting decolonization efforts have important implications for future practice and research, and particularly in our understanding of graduating Native engineers at NNCUs.

The second tenet of TribalCrit recognizes that policies in the United States toward Native Americans has and continues to be "rooted in imperialism, white supremacy, and desire for material gain" (Brayboy, 2006, p. 431). TribalCrit argues that white supremacy is viewed as "natural and legitimate" and that the western way has both "moral and intellectual superiority over those things non-western" (Brayboy, 2006, p. 432). In this study, white supremacy is displayed from early on when high school counselors attempted to direct Xander and Quetzalli to trade schools. Then, it continues in the curriculum during students' undergraduate years, and is

showcased through the racism students endured as the "norm" throughout their college years. It is further heightened when white students are the majority and share homework solutions only within their groups and treat Indigenous students as inferior. Professors treating students inequitably with family responsibilities or failing them for not exuding enough passion are other ways that white supremacists' notions are integrated into the foundations of the academy, and even more so with the "weeding out" nature of the curriculum in engineering majors. These experiences have a common thread of denoting Indigenous students and their perspectives as inferior to the dominant culture.

The fifth tenet of TribalCrit challenges Westernized notions of culture, knowledge, and power, and instead acknowledges these concepts from an Indigenous lens as fluid and stable (Brayboy, 2006). In addition, Brayboy (2006) emphasizes Indigenous peoples' connection to a physical place, as "culture is rooted to the lands on which they live as well as to their ancestors who lived on those lands before them" (Brayboy, 2006, p. 434). When thinking of how each of the seven engineering students made their college decision, proximity to home was an integral piece. Additionally, Quetzalli noted her connection to her grandfather's story in reference to their relationship with the land and resources in constructing structures, which influenced her career trajectory. Nature and the cosmos influenced Josefina's love for astronomy and eventually in landing her at her institution studying aerospace engineering. Their careers and institutions of choice were viewed through an Indigenous lens of relationality to land and beings in giving back.

Furthermore, TribalCrit's sixth tenet acknowledges three forms of knowledge that intersect for Indigenous people: cultural knowledge, knowledge of survival, and academic knowledge (Brayboy, 2006). Blending each of these distinct forms of knowledge generates power and a pathway to survival for Indigenous students. As noted previously, all of the students

in this study utilized survivance to persevere through the many obstacles along their journey and identified their cultural identity as essential to their success. Quetzalli noted the usefulness of knowing how to write grants for her community, and Josefina and Micah participated in K-12 STEM outreach programs to engage with younger Indigenous students. They saw the benefits of gaining the academic knowledge to pair with cultural and survival knowledges to offer resources to give back to their communities.

The seventh tenet of TribalCrit emphasizes the importance of tribal philosophies, beliefs, traditions, and customs (Brayboy, 2006). It particularly honors analyzing Indigenous student experiences through an Indigenous lens. Findings from this study affirm this tenet, as Indigenous methodologies and epistemologies were utilized by an Indigenous researcher to co-construct collective knowledge with Indigenous engineering students. This perspective demonstrates the value of interconnectedness in shared cultural beliefs. Conversely, the dominant perspective may have approached concepts such as survivance, support systems, and racism and isolation very differently. Just as TribalCrit discussed and this study showed, individuality was devalued while contributing to community success was valued.

Lastly, the eighth tenet of TribalCrit "honors stories and oral knowledge as real and legitimate forms of data and ways of being" (Brayboy, 2006, p. 439). Stories help us understand who we are as tribal peoples and serves as a means for passing down that knowledge through generations. While this type of knowledge diverges with what knowledge and research is privileged in the academy, TribalCrit acknowledges that there is "saliency in stories" (Brayboy, 2006, p. 439). Additionally, Brayboy (2006) emphasizes the difference between just listening to stories and hearing them, and asserts that "hearing stories means that value is attributed to them and boy the authority and the nuance of stories are understood" (p. 440).

Stories have played a central role in this study in conveying experiences of the Indigenous engineering students and their journeys throughout their early childhood to undergraduate years in engineering. Their stories have individual and collective power and assert the importance of utilizing oral traditions when conducting research with Indigenous people by Indigenous researchers. Findings from this study affirm that stories are legitimate forms of data and provide ways for healing and reclamation of our value as Indigenous researchers armed with Indigenous knowledge in the academy.

Indigenous research paradigm. As has been discussed in regards to TribalCrit, our relation to things is important to understand in regards to our epistemologies, ontologies, and axiologies as Indigenous people. Wilson's (2008) Indigenous research paradigm furthers this understanding and is woven throughout the entirety of my study. As I delved into my research, I continued to think through this paradigm in reference to my findings that the participants and I co-constructed collectively. Wilson (2008) explains the power of the *relationality* component of Indigenous research paradigm:

> Knowledge itself is held in the relationships and connections formed with the environment that surrounds us. This reinforces the earlier point that knowledge, theories and ideas are only knots in the strands of *relationality* that are not physically visible but are nonetheless real. Second is the concept of the linking of the space between people with the relationship that they share. This is important for me to bring out here, and I will talk about it more in a couple of pages. The space and therefore the relationship between people or between people and their environment is seen as a sacred key concept within many Indigenous peoples' spirituality. By reducing the space between things, we are strengthening the relationship that they share. And this bringing things together so that

> they share the same space is what ceremony is about. This is why research itself is a sacred ceremony within an Indigenous research paradigm, as it is all about building relationships and bridging this sacred space. (p. 87)

Just as the Utiyvhi (balance) in Engineering model reflects, Indigenous research paradigm creates balance and harmony as it bridges things together in a relational manner. In my co-constructed model in tandem with my participants, we were able to create a culturally relevant way of connecting each of their experiences together to create a powerful collective story. The continuous circle indicates how each element connects and keeps going to guide future generations of Native students in improving their experiences in engineering programs at four-year, public NNCUs.

Circling back to Archibald's (2008) Indigenous Storywork, the focus on the seven principles of respect, reciprocity, responsibility, reverence, holism, interrelatedness, and synergy, ground this study. The interrelatedness of us as Indigenous people to the elements of land, water, fire, and the cosmos remind us of our relations with all things. Current examples of Indigenous ways of knowing and being conflicting with colonial conquests include the Standing Rock Sioux resistance to stop the construction of the Dakota Access Pipeline, and Native Hawaiians' resistance against the building of a massive telescope at the top of the sacred Mauna Kea volcano (Estes, 2019; Tachine, 2019). How we view the land and its resources is more as a living being that provides for us, and thus we treat the land with respect and well-being. Adding pipelines or telescopes are purely for capital and monetary gain and disrespect the sacred Indigenous lands, which furthers the mission of settler colonial conquests (Peralto, 2014; Tachine, 2019). Wolfe (2006) describes settler colonialism as a means to "destroy to replace" (p. 388). These are two prime examples of how settler colonialism still pervades our Indigenous livelihood, and how we

view the land and other elements in a relational manner, bringing a more environmentally conscious and spiritual approach to how we treat resources. This relational approach can be translated into how these seven engineering students viewed themselves in relation to their future careers as engineers from an early point in life, and that was continuously nurtured through various critical points in their lives. The four lessons begin from the early childhood years and their first connection to STEM, and move through their current experiences in their engineering programs, revealing a myriad of relationships along the way: relationship to family, relationship to space and place, relationship to identity and community, and relationship with their engineering discipline.

Relationship to family. Throughout all of the seven students' stories, family support and encouragement from an early age was an integral component. Native American student college persistence literature identify family as key to Native student success (Benjamin, Chambers, & Reiterman, 2010; Guillory & Wolverton, 2008; HeavyRunner & DeCelles, 2002; Huffman, 2001; Jackson et al., 2003; Larimore & McClellan, 2005; Lee et al., 2010; Lundberg, 2007; Pewewardy & Frey, 2004). Family members planted the early seeds of interest in and *fascination* with STEM through their math and science preparation, and support of higher education. They encouraged their attendance at college fairs, or other STEM-related activities in their pre-college years. Continuing throughout their undergraduate experience, many of the participants noted family members as being instrumental in their persistence through words of encouragement through difficult challenges. While many of the parents and family members had varying levels of educational attainment, that did not prohibit their encouragement and support of their children's pursuit of a college degree. The central role of family was made evident in Bree's

acceptance of a job opportunity close to home to be near family, and many of the participants' college choice as being close to home.

Relationship to space and place. Each of the students felt a connection with their respective four-year, public campuses prior to attending as an undergraduate student. Proximity to home and the emphasis on *place* was important in their college decisions. For Micah, Hank, Bree, and Marcus, they had grown up visiting their campuses, and their families were already big supporters of the institutions. For Josefina, she chose her institution based on being close to nature and culturally relevant programs offered. For the nontraditional students Xander and Quetzalli, they remained close to home even after attending two-year colleges before their four-year public institutional choices. Once at their institutions, they relied on their family support at home, Native support programs, and engineering faculty relationships to build their community away from home. Thus, the importance of *space* emerged through their finding cultural centers, organizations, and support systems within their institutions. Minthorn and Nelson (2018) distinguish the relational concepts in stating that "*space* is primarily the physical location while *place* is the point of interaction and the ability to process the meaning of those interactions" (p. 75). Deloria and Wildcat (2001) further this explanation of *place* in recognizing it as not only physical space, but as a space that considers the historical, emotional, and sociopolitical contexts that ultimately create and inform experiences.

Furthermore, through forging relationships with other Native peers, faculty, and staff, they were able to flourish and persist. These communities away from home offered them resources in the form of scholarships, on-campus jobs, and internship opportunities. Additionally, each of them became leaders in various Indigenous and/or engineering organizations on campus, furthering their relational connection to space and place.

Relationship to identity and community. Due to colonization effects of grandparents' attending boarding schools and their tribal languages not being spoken much in their households, students had to find ways to stay connected, or for some to reconnect, with their Indigenous and individual tribal identities. Josefina's involvement in her Native cultural center gave her access to beadwork classes and she started taking online language classes through her tribal nation. Not only did the students see the value in being accountable to themselves and their families, but also they held themselves accountable to future Native students entering college, and going into engineering fields. Each of them found ways to give back, whether directly or indirectly. Micah enjoyed the lab tours he gave to Native youth, and Josefina enjoyed participating in summer STEM programming through her Native cultural center. Quetzalli discovered the value of all of the resources she was able to access and then give back through her community tutoring program, which also inspired her pursuit of a doctoral degree in structural engineering to become a future faculty member. Bree is now working with her current employer to get them involved at AISES national conferences and recruitment of Native students. Xander found solace in AISES in connecting his peers with internship opportunities.

Throughout their early childhood years to now, each of the seven engineering students noted their cultural identity as being integral to their success. As previously mentioned, the literature supports a strong sense of cultural identity as being linked to Native student persistence in higher education (Brayboy, 2005; Chow-Garcia, 2016; Deyhle, 1995; Huffman, 2001; Jackson & Smith, 2001; Kirkness & Barnhardt, 1991; Tachine, 2015; Waterman, 2007). Quetzalli and Hank relied on their ceremonial and spiritual practices to keep them balanced throughout their programs. Additionally, through Native cultural center programming to Native student organization involvement, students were able to strengthen their connections to their identities

and build community with other Native peers, faculty, and staff. This notion of cultural integrity – understanding who they are – in relation with familial and tribal nation ties, provided confidence and balance in understanding their purpose in life and why they are obtaining these college degrees.

Relationship to engineering discipline. Through involvement in organizations such as AISES and SACNAS on campus, students were able to forge connections with other Native students in engineering and science disciplines. Furthermore, through these organizations and connecting with faculty, they were able to obtain relevant internship and/or research and lab experiences to affirm their love for their respective engineering disciplines. The experiential learning components allowed them to socialize into their respective fields and have a clearer vision of the applicable contributions they could make in the field.

From an early age, sparking the students' fascination with engineering through visiting theme parks to high school hands-on projects or facility tours made an impact on their future pursuit of their engineering discipline. Having mentors in the form of teachers, older students, and parents or family members during their pre-collegiate years who encouraged their pursuit of engineering put this pathway at the forefront of their minds. They were able to understand the connection of their interests with future careers by seeing and hearing about their applicability. Engineering became more visible and they began to understand it as a viable career path.

Collectively, all of these relational aspects created pathways to persistence for the seven engineering students. All of these relationships are interconnected throughout the seven engineering students' journeys. Together, this relational cycle led to Utiyvhi (balance), which in turn, led to their continuing through their programs. Remaining at the core of this Utiyvhi (balance) was their maintenance and continued nurturing of their sacred fire – their cultural

identities as Indigenous peoples tied to tribal nations. All of these elements created the *medicine* they each needed to persist in these non-Native institutional spaces. DeLoria and Wildcat (2001) support this notion in advocating that:

> In an indigenous practice of education informed by an experiential metaphysics, the focus of self-determination is on the manner in which our being and identity itself is constituted of the number of good relationships we are part of and actively maintain. Self-determination cannot be an individual question, for the reflective sense in which our selves are grounded in life among our relations and in the relationships surrounding us requires engagement with the community of persons, both human and other-than-human, when we determine what we ought to do, what choices we should make, and how we should be self-determining. (p. 148)

Implications for Practice, Policy and Research

As Wilson (2008) states several times in explaining Indigenous research paradigm, "research is ceremony" and this "research that we do as Indigenous people is a ceremony that allows us a raised level of consciousness and insight into our world" (p. 137). Upon completing this research study, I feel transformed and back in balance with my physical, emotional, mental, and spiritual facets of my being.

Practice. This study offers invaluable insight into the lived experiences of undergraduate Native students in engineering programs who are persisting towards graduation. Much remains to be learned about Native students persisting in engineering programs as they move beyond the "American Indian research asterisk," where they are often "excluded from institutional data and reporting, omitted from the curriculum, absent from the research and literature, and virtually written out of the higher education story" (Shotton et al., 2013, p. 2). As a result of my findings,

it is necessary to begin reaching out during the early childhood years to expose Native students to engineering concepts and role models, as well as ensuring they connect with faculty, staff and their peers on the campus before making college decisions. Lastly, once they are on the campus, providing a space devoted to Native students, as well as connecting them with Native support programs and relevant student organizations is vital to their success in college and beyond.

Nurturing connection to engineering at the K-12 level. As learned from the findings, nurturing an early fascination for math and science and engineering concepts, as well as foundational knowledge of the mainstream institution is vital to Native student success in engineering. The institution must be intentional in seeking out schools in local Native communities to visit and host hands-on engineering activities led by Native engineering students. The hands-on activity would need to be relevant to the communities they are visiting and make the connection between engineering and the real-world impact. As discussed in Chapters one and two, much of the dissonance between Indigenous communities and STEM is not having a clear understanding of how these professions are beneficial to society and tribal communities (Miller, 2010; Tsui, 2007). The messaging surrounding engineering, and the way it is presented is important in outreaching to tribal communities. If an AISES or SACNAS chapter does not exist, there needs to be departmental efforts from the engineering college to create a chapter, preferably with an Indigenous faculty and staff member serving as advisors. Involving the institution's chapter of AISES or SACNAS in these visits would provide role models early on and indicate investment of support for Natives in engineering. The AISES or SACNAS chapter could even help start high school chapters at a few local schools to build that bridge between the high school and mainstream institutions. AISES offers many programs at the pre-college level to include "virtual science fairs, an energy-specific science fair, workshops to support student

participation in science fairs, a science bowl, and paid internships" (Lee Bitsoi & Lowe, 2018, p. 93). Furthermore, AISES recently announced that they started their first tribal chapters with the Eastern Band of Cherokee Indians and Shkodedeajek Chapter of the Citizen Potawatomi Nation (McKie, 2019). These efforts provide a plethora of resources to these tribal nations and prioritize awareness and retention in K-12 STEM, as well as increasing access and success in STEM at the higher education level (McKie, 2019). Continuing efforts to partner with tribal communities with create a relationship that is beneficial to both the institution and tribal nation.

Since family involvement is critical, hosting programs that create awareness around engineering and college will increase their knowledge and resource base. This might be hosting evening workshops in tribal communities to inform parents, teachers, and counselors of the college application process, scholarship opportunities, and other preparation strategies for studying engineering. Messaging will be critical in making it relevant to the needs of each tribal community. Involving the engineering faculty and support program staff, particularly those that are Indigenous, would be most beneficial.

Building community at the college level. NNCUs must provide an orientation for Native students to the campus, providing important resources, and connecting them with Native support programs and engineering organizations, faculty in the engineering department, and other Native faculty and staff. Involving the family in orientation programs and other student affairs programming at the collegiate level is equally as important (Guillory & Wolverton, 2008; Shotton et al., 2013). Such examples include inviting families to campus with the students at a STEM, or engineering-specific orientation, with introduction of Native and non-Native faculty and staff who are familiar with Native student needs.

Elders bring a sense of comfort and belonging for Native students and can strengthen bonds amongst the institution and tribal communities (Shotton et al., 2013). Involving elders in the program to bless the start of their collegiate journey would show dedication and inclusion of Native identity and culture (Shotton et al., 2013). Furthermore, NNCUs need to link students early on to Native peer mentors and Native alumni in the engineering workforce or working for their tribal nations to share their strategies for success, as well as to help support them in this new environment. Providing a Native peer-to-peer mentoring program or alumni mentoring program, specifically connecting engineering and science majors, would allow Native students to feel supported and overcome potential barriers to academic persistence and success (Shotton et al., 2007).

Institutions continuing to support the development of AISES and/or SACNAS chapters is imperative. As noted by each of the seven engineering students, these organizations bridging their cultural connections to their engineering disciplines created a unique space for professional development, scholarship, and internship opportunities. Attending these professional conferences provided networking and mentoring opportunities with other Indigenous peers, opening their eyes to a world of opportunities in their engineering disciplines. Supporting an AISES and/or SACNAS chapter requires departmental commitment in terms of financial resources and a strong faculty and staff advisor to dedicate time to the chapter's development.

Additionally, living learning communities have been linked to persistence for engineering students (Ballard, 2005; Belichesky-Larson, 2013; Nakamoto, 2011; Shapiro & Sax, 2011; Zundhl, Stiltz, & Buettner, 2015). For Native students, culturally relevant spaces are essential to their success and can make a difference in how they navigate existence at NNCUs. Like Shotton, Lowe, and Waterman (2013) address, dedicating a place on campus for Native students to live

with other Native students surrounded by Native images would be ideal. Some institutions have already implemented such culturally relevant living units, such as Cornell University and Dartmouth College (Ecklund & Terrance, 2013). The culturally relevant piece coupled with discipline-specific floors and STEM learning spaces would create a home-like environment for Native students in engineering programs. These spaces create an environment conducive to practicing ceremonies and other traditional expressions, and ones that can host families visiting the university (Ecklund & Terrance, 2013). Scholars have found that students who participate in living-learning communities have smoother transitions to college, spent more time discussing academic topics with more interaction with faculty, and reported more confidence in their academic skills leading to a greater likelihood of graduation (Inkelas, Soldner, & Szelenyi, 2008; Inkelas, Szelenyi, Soldner, & Brower, 2007; Johnson et al., 2007). A Natives in STEM living-learning community may alleviate some of the first-year encounters experienced by many of the participants in this study.

For curricular experiences, engineering programs must make a commitment to providing links to "Native language, culture, and traditions through place- and inquiry-based approaches that directly address the math, science, and engineering needs of the tribal communities served" (Lee Bitsoi & Lowe, 2018, p. 101). As noted in Chapter two, a dissonance in epistemologies in Westernized STEM degree programs at NNCUs has been a detractor for many Native students that may have otherwise considered engineering pathways (Chow-Garcia, 2016; Lee Bitsoi & Lowe, 2018; Lundberg, 2007; Seymour & Hewitt, 1997; Smith et al., 2014). Not only do more Indigenous faculty need to be hired to bring culturally relevant curriculum to engineering programs, but expectations and trainings need to be instituted for engineering faculty of all backgrounds in understanding the needs of tribal communities and connecting faculty and

students with community-based research projects or internships (Lee Bitsoi & Lowe, 2018). Bringing tribal leaders in to engage with the faculty for formal and informal gatherings would also allow for a deeper understanding of tribal needs and relationship-building.

Overall, truly integrating these efforts as a part of a holistic plan as a part of the fabric of the institution is vital to creating access and support to Indigenous students entering four-year, public NNCUs. Departments must collaborate and dedicate financial resources in a collective and resourceful manner to bring these efforts to life. As is seen and understood in the Utiyvhi (balance) in Engineering model, Indigenous students view their experience as a series of relationships. As is displayed with the circular process to achieve Utiyvhi (balance), the intentional placing of these elements in a circle indicates that they are interrelated and that there is a seamless blending from one to the next (Wilson, 2008). The NNCU must embody this same cyclical and culturally relevant model in how it approaches the outreach, recruitment and support efforts for Indigenous engineering students.

Policy. As discussed in Chapter one, the U.S. government has allotted millions of dollars toward diversifying STEM at the higher education and workforce levels. However, what is noticeable is the fragmented approach of each of these efforts. Additionally, students of color were lumped together as if there are not specific targeted needs for each group. The continuing effort toward assimilation is at the core of these federal efforts in pushing toward the Westernized ways of approaching STEM education. What this study offers policy makers is a look at a relational and interconnected approach in promoting STEM to Indigenous students from the early childhood years forward, shining a light on the need to integrate family, community, and culture into these efforts. Engineering, as a part of STEM, needs to be distinguished and shared in clear messaging with relevant connections to tribal communities and

the greater community impact. Policy should comprehensively address STEM pathways from early in elementary school throughout their higher education journeys, and a financial commitment to these efforts is necessary.

In reference to higher education policy specific to mainstream institutions, an administrative role should be created to elevate an Indigenous professional to the status to influence such policy changes (Francis-Begay, 2013). This shows an institutional commitment toward higher-level Indigenous relation efforts, in forging connections to local tribal nations and colleges, recruiting and hiring more Indigenous faculty and staff, and in creating necessary policy changes to support Indigenous students at all levels of the institution. Taking this a step further, designating a person or office to increasing participation in STEM for Native students would be ideal. Chow-Garcia (2016) notes these integral units as Native American STEM Student Support Units, whereas they are formed with Indigenously guided mission statements and support the STEM pathway from K-12 outreach to support as college students. However, while this unit is necessary, I would argue that this involves collaboration across departments, making it more than just one unit's commitment to increasing Indigenous student support. Consequently, my suggestion would be to push for more decentralized efforts across STEM departments, having a position or positions dedicated to Indigenous student recruitment and retention efforts who then report to a higher-level tribal liaison or special advisor position, creating more cohesive efforts in creating more culturally relevant STEM curriculum, policy, outreach efforts, and support systems. Since engineering has been known to have a disconnection in messaging to tribal communities, a dynamic and decentralized effort like this would be the ultimate institutional commitment to increasing the Indigenous student experience in engineering and other STEM majors.

Finally, involving students in the influence of institutional policy efforts is imperative. Creating an advisory committee or task force made up of Indigenous student leaders to advise the President and his special advisor to tribal relations would not only create leadership opportunities for the students but an environment where their individual and collective voices are acknowledged and valued. Just like Josefina and Marcus have experienced on their multicultural advisory committee, they have been able to create programs and other important changes at their respective institutions being involved on such a committee. This has created a sense of belonging and impact beyond just their department. This is also a way for them to advocate for other Indigenous engineering students like themselves in improving their experiences.

Research. As this research was a powerful, co-constructed effort, I am hopeful that scholars from all backgrounds will come away with lessons learned. Moving away from the damaging deficit discourse surrounding Native students in the academy, this study highlighted the individual and collective voices of seven Indigenous engineering students successfully persisting in engineering programs at NNCUs. Additionally, this study centered on engineering programs specifically, not lumping STEM majors together. Each of the participants were eager to share their stories and were surprised at the opportunity to do so, as the few Indigenous students surviving in engineering majors at NNCUs. While this study highlights the varied levels of relation to their Indigenous culture, and the varied experiences from nontraditional to traditional pathways through higher education, many common threads were discovered in their collective experiences. As their voices have been made invisible in the literature to date, this study illuminates their unique and varied pathways to and through engineering programs that honors their ancestors, offers considerations for NNCU administrators, and encourages future

Native students to consider engineering pathways for the betterment of their own tribal communities and sovereignty.

Due to the lack of knowledge of Indigenous engineering student experiences, the opportunities for future research are endless. While this research was limited in scope with seven participants, the rich narratives provided much insight. However, the findings may not be generalizable to all Indigenous students who come from a combination of urban, rural and reservation experiences, with varying levels of cultural knowledge. For the students in this study, most were raised in predominantly white communities, which can ease the transition to a predominantly white campus than may be for students from reservations who are surrounded by other Native people daily. Thus, more research is necessary with students from traditional reservation environments persisting in undergraduate engineering programs at NNCUs to understand the diverse needs of our Native students.

Additionally, this study provided future directions for research on intersectionality of identities for Native students. Studies on just Native women's or men's persistence in engineering programs, as well as LGBTQ Native students' persistence would be valuable to providing more insight on how multiple identities intersect and give different meaning to lived experiences. In order to better serve the diverse needs of our Indigenous students, we must not only listen to their stories, but seek to understand how they make meaning of their experiences.

Summary

At the heart of this study was the quest for knowledge to assist in an understanding of Indigenous student experiences in undergraduate engineering program at NNCUs. With the startling dismal numbers of Indigenous students graduating with these valuable degrees, I wanted

to open a research doorway that would illuminate Indigenous student voices in these fields, as well as to inform future practice, policy, and research in this area. When an entire group of people are invisible and silenced, there is a need to take action.

This is an urgent call for administrators to listen, understand, and allocate resources toward making significant change and impact for the future of STEM in our country, as well as the protection of important tribal resources. Indigenous students have the potential to be armed with Indigenous knowledge and academic knowledge to transform our tribal communities and provide culturally relevant solutions to problems facing tribal nations today. Not only is it important to learn about ways to increase participation from Native students, but there must be an institutional commitment to hiring more Native faculty, staff, and administrators to provide relevant support across campus and in engineering departments. As Engstrom and Tinto (2008) acknowledge, "access without support is not opportunity," and higher education administrators must allocate resources – both human and financial – to providing support for Indigenous students (p. 50). Fragmented approaches are not useful, as they ignore the interconnected and relational pathways of Indigenous students. Thus, increasing recruitment efforts without a holistic, continuous plan of connection from early childhood years through their collegiate experiences will ultimately fail.

In order to reach and maintain Utiyvhi (balance) at NNCUs that will benefit tribal communities and the greater society, it is crucial to understand the lived experiences of Indigenous engineering students. These engineering graduates are invaluable to our survival as Indigenous people as they can navigate both the Western and Indigenous worlds. Armed with these problem-solving skills learned in the academy and from their own tribal nations, they are a powerful force that can protect our land and water resources, assist in healthcare, technology,

and infrastructure advancements. To support future Indigenous engineers, we must understand how they came to be successful in their programs by listening and hearing their stories. As I have been transformed through this experience of learning from the seven Indigenous engineering students, I hope others will gain invaluable insight that is applicable to their institutions, and will inspire them to take action on bringing attention to this severely underrepresented and invisible group of Indigenous engineering students.

References

AIHEC. (2019a). American Indian Higher Education Consortium: The TCU movement. Retrieved from http://www.aihec.org/our-stories/TCUmovement.htm

AIHEC. (2019b). American Indian Higher Education Consortium: Our Initiatives. Retrieved from http://www.aihec.org/what-we-do/initiatives.htm

AIHEC (n.d.). *Living science: Strengthening and sharing Native knowledge at TCUs*. Retrieved from http://www.aihec.org/our-stories/docs/reports/STEM-LivingScience.pdf

AISES. (2014). AISES receives $1.5 million NSF grant. Retrieved from http://www.aises.org/content/aises-receives-15-million-nsf-grant-press-release

American Council on Education (2010). College enrollment. In D. J. Wilds (Ed.), *Minorities in higher education 1999-2000: Seventeenth annual report* (pp. 17-22). Washington, DC: Author.

American Indian College Fund (2019). *Creating visibility and healthy learning environments for Native Americans in higher education: Declaration of Native purpose in higher education: An Indigenous higher education equity initiative*. Denver, CO: Author.

Anderson, E. L., & Kim, D. (2006). Increasing the success of minority students in science and technology. Washington, DC: American Council on Education. Retrieved from http://www.acenet.edu/news-room/Documents/Increasing-the-Success-of-Minority-Students-in-Science-and-Technology-2006.pdf

Anderson, E. L., Williams, K. L., Ponjuan, L., & Frierson, H. (2018). The 2018 status report on engineering education: A snapshot of diversity in degrees conferred in engineering, Association of Public & Land-grant Universities: Washington, D.C.

Apple, M. W., & King, N. P. (1977). What do schools teach? In R. H. Weller (Ed.), *Humanistic education* (pp. 29-63). Berkeley, CA: McCutchan.

Archibald, J. (2008). Indigenous storywork: Educating the heart, mind, body, and spirit. Vancouver, BC: UBC Press.

Aud, S., Hussar, W., Kena, G., Bianco, K., Frohlich, L., Kemp, J., & Tahan, K. (2011). *The Condition of Education 2011* (NCES 2011-033). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist 37*(2), 122–147.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.

Benjamin, D. P., Chambers, S., & Reiterman, G. (1993). A focus on American Indian college persistence. *Journal of American Indian Education, 32*(2), 24-40.

Boyer, P. (1997). *Native American colleges: Progress and prospects.* Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.

Brayboy, B. M. (2006). Toward a tribal critical race theory in education. *The Urban Review, 37*(5), 425-446.

Brayboy, B. M. & Deyhle, D. (2000). Insider-outsider: Researchers in American Indian communities. *Theory into Practice, 39*(3), 163-169.

Brayboy, B. M. J., Fann, A. J., Castagno, A. E., & Solyom, J. (Eds.). (2012). Postsecondary education for American Indian and Alaska Natives: Higher education for nation building and self-determination. *ASHE Higher Education Report Series, 37*(5).

Brown, L. & Robinson-Kurpius, S.E. (1997). Psychosocial factors influencing academic

persistence of American Indian college students. *Journal of College Development, 38,* 3-12.

Byars-Winston, A., Estrada, Y., Howard, C., Davis, D., & Zalapa, J. (2010). Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: A multiple-groups analysis. *Journal of Counseling Psychology, 57*(2), 205-218. doi: 10.1037/a0018608

Cabrera, A., Colbeck, C., & Terenzini, P. (2001). Developing performance indicators for assessing classroom teaching practices and student learning: The case of engineering. *Research in Higher Education, 42,* 327-352.

Cajete, G. (1999). *Native science: Natural laws of interdependence.* Santa Fe, NM: Clear Light Books.

Calmore, J. (1992). Critical race theory, Archie Shepp, and fire music: Securing an authentic intellectual life in a multicultural world. *Southern California Law Review, 65,* 2129-2231.

Carnevale, A., Smith, N., & Melton, M. (2011). *STEM.* Washington, DC: Georgetown University Center on Education and the Workforce. Retrieved from https://cew.georgetown.edu/wp-content/uploads/2014/11/stem-execsum.pdf

Carney, C. M. (1999). *Native American higher education in the United States.* New Brunswick, N.J.: Routledge.

Chang, M. J., Cerna, O., Han, J., & Sàenz, V. (2008). The contradictory roles of institutional status in retaining underrepresented minorities in biomedical and behavioral science majors. *Review of Higher Education, 31*(4), 433–464.

Chen, X. (2009). *Students who study science, technology, engineering, and mathematics in postsecondary education* (NCES 2009-161). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Chen, X., & Soldner, M. (2013). *STEM attrition: College students' paths into and out of STEM fields* (NCES 2014-001). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Chow-Garcia, N. (2016). Educational Pathways for Native American Graduates: Stories through the STEM Bachelor's, Master's, and Doctoral Degrees (Doctoral dissertation, University of Rochester).

Chubin, D. E., & Babco, E. L. (2003). *Walking the talk in retention-to-graduation: Institutional production of minority engineers – A NACME analysis*, Commission on Professionals in Science and Technology. Retrieved from www.cpst.org/WalktheTalk.pdf

Colby, S.L. & Ortman, J.M. (2015). Projections of the size and composition of the U.S. population: 2014 to 2060, Current Population Reports, P25-1143, U.S. Census Bureau, Washington, DC. Retrieved from http://www.census.gov/content/dam/Census/library/publications/2015/demo/p25 1143.pdf

Cole, D., & Espinosa, A. (2008). Examining the academic success of Latino students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Student Development, 49,* 285-300.

Cole, T. (2012). The white savior industrial complex. *The Atlantic*. Retrieved from https://www.theatlantic.com/international/archive/2012/03/the-white-savior-industrial-complex/254843/.

Conrad, C. & Gasman, M. (2015). *Educating a Diverse Nation: Lessons from Minority-Serving Institutions,* Cambridge, MA: Harvard University Press.

Crenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color. *Stanford Law Review, 43*(6), 1241-1299.

Culotta, E. (1992). Scientists of the future: Jumping high hurdles. *Science, 258,* 1209-1213.

Deloria, V. (1970). *We talk, you listen: New tribes, new turf.* New York: Macmillan.

Deyhle, D. (1992). Constructing failure and maintaining cultural identity: Navajo and Ute school leavers. *Journal of American Indian Education, 31*, 24-47.

Deyhle, D. (1995). Navajo youth and Anglo racism: Cultural integrity and resistance. *Harvard Educational Review, 65*(3), 403–444.

Delgado, R. & Stefancic, J. (2000). *Critical race theory: An introduction.* New York: NYU Press.

Demmert, W. G., Grissmer, D., & Towner (2006). A review and analysis of the research on Native American students. *Journal of American Indian Education, 45*(3), 5-23.

DeVoe, J. F., Darling-Churchill, K. E., & Snyder, T. D. (2008). *Status and trends in the education of American Indians and Alaska Natives: 2008.* (NCES 2008-08). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U. S. Department of Education.

Dika, S. L. & Singh, K. (2002). Applications of social capital in educational literature: A critical synthesis. *Review of Educational Research, 72*(1), 31-60. doi: 10.3102/00346543072001031

Dixson, A. D. and Rousseau, C. K. (2006). And we are still not saved: Critical race theory in education ten years later. In A. D. Dixson and C. K. Rousseau (Eds.) *Critical race theory in education: All God's children got a song.* New York: Routledge.

Dowling, M. (2005). From Husserl to van Manen. A review of different phenomenological approaches. *International Journal of Nursing Studies, 44,* 131-142. doi: 10.1016/j.ijnurstu.2005.11.026

Duckworth, A. (2018). *Grit: The power of passion and perseverance.* New York: Scribner.

Ecklund, T. & Terrance, D. (2013). Extending the rafters: Cultural context for Native American students. In H. Shotton, S. Lowe & S. Waterman (Eds.) *Beyond the asterisk: Understanding Native students in higher education* (pp. 53-66). Sterling, VA: Stylus Publishing LLC.

Educate to innovate (2013). Retrieved from https://obamawhitehouse.archives.gov/issues/education/k-12/educate-innovate

Elliott, R. A., Strenta, C., Adair, R., Matier, M., & Scott, J. (1996). The role of ethnicity in choosing and leaving science in highly selective institutions. *Research in Higher Education, 37,* 81-709.

Engstrom, C., & Tinto, V. (2008). Access without support is not opportunity. *Change, 40*(1), 46-50. Retrieved from http://www.jstor.org/stable/40178285

Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*(2), 209-240.

Estes, N. (2019). *Our history is the future: Standing Rock versus the Dakota access pipeline, and the long tradition of Indigenous resistance.* Brooklyn, NY: Verso.

Falk, D. R., & Aitken, L. P. (1984). Promoting retention among American Indian college students. *Journal of American Indian Education, 23*(2), 24-31.

Fantz, T. D., Siller, T. J., & DeMiranda, M. A. (2011). Pre-collegiate factors influencing the self-efficacy of engineering students. *Journal of Engineering Education, 100*(3), 604-623.

Fast, E., & Kovach, M. (2019). Community relationships within Indigenous methodologies. In S. Windchief, T. San Pedro (Eds.), *Applying Indigenous research methods: Storying with peoples and communities* (pp. 21-36). New York: Routledge.

Flower III, A. M. (2014). Building an academic community: Minority serving institutions and how they influence students pursuing undergraduate degrees in STEM. *Multicultural Learning and Teaching, 9*(2), 187-201. doi 10.1515/mlt-2012-0042

Francis-Begay, F. (2013). The role of the special advisor to the president on Native American affairs. In H. Shotton, S. Lowe & S. Waterman (Eds.) *Beyond the asterisk: Understanding Native students in higher education* (pp. 81-94). Sterling, VA: Stylus Publishing LLC.

Fryberg, S. A., & Townsend, S. S. M. (2008). The psychology of invisibility. In G. Adams, M. Biernat, N. R. Branscombe, C. S. Crandall, & L. S. Wrightsman (Eds.), *Commemorating Brown: The psychology of racism and discrimination* (pp. 173-193). Washington, DC: American Psychological Association.

Gans, H. J. (1979) Symbolic ethnicity: The future of ethnic groups and cultures in America. *Ethnic and Racial Studies, 2*(1), 1-20. doi: 10.1080/01419870.1979.9993248

Geisinger, B. N. & Raman, D. R. (2013). Why they leave: Understanding student attrition from engineering majors. *International Journal of Engineering Education, 29*(4), 914-925.

Georges, A. (1999). Keeping what we've got: Effective strategies for retaining minority freshmen in engineering. *NACME Research Letter, 9,* 1-19.

Gillette, J. & Thiele, R. (2015, February 12). The White House launches the "Generation Indigenous Native Youth Challenge". President Obama and the Native American [Web blog post]. Retrieved from https://www.whitehouse.gov/blog/2015/02/12/white-house-launches generation- indigenous-native-youth-challenge

Glesne, C. & Peshkin, A. (1992). *Becoming qualitative researchers.* White Plains, NY: Longman.

Gloria, A. M., & Robinson Kurpius, S. E. (2001). Influences of self-beliefs, social support, and comfort in the university environment on the academic nonpersistence decisions of American Indian undergraduates. *Cultural Diversity and Ethnic Minority Psychology*, *7*(1), 88.

Golden, N. A. (2015). “There’s still that window that’s open”: The problem with “grit.” *Urban Education, 52*(3): 343-369. doi: 10.1177/0042085915613557

Grande, S. (2000). American Indian identity and intellectualism: The new quest for a new red pedagogy. *Qualitative Studies in Education, 13,* 343-359.

Griffin, K. A., Perez II, D., Holmes, A. P. E., & Mayo, C. E. P. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. *New Directions for Institutional Research, 148,* 95-103. doi: 10.1002/ir.365

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review, 29,* 911-922.

Guillory, R.M., & Wolverton, M. (2008). It’s about family: Native American student persistence in higher education. *The Journal of Higher Education*, *79*(1), 58-87.

Guillory, J. P. & Ward, K. (2008). Tribal colleges and universities: Identity, invisibility, and current issues. In M. Gasman, B. Baez, C. S. V. Turner (Eds.), *Understanding minority-serving institutions* (pp. 91-110). Albany, NY: State University of New York Press.

Handelsman, J., & Smith, M. (2016, February 11). STEM for all. Retrieved from https://obamawhitehouse.archives.gov/blog/2016/02/11/stem-all

Harper, S. (2012). Race without racism: How higher education researchers minimize racist institutional norms. *The Review of Higher Education*, 36, 9–29.

Heinrich, R. K., Corbine, J. L., & Thomas, K. R. (1990). Counseling Native Americans. *Journal of Counseling and Development, 69,* 128–133.

HeavyRunner, I., & DeCelles, R. (2002). Family education model: Meeting the student retention challenge. *Journal of American Indian Education, 41*(2), 29-37.

Heinrich, R. K., Corbine, J. L., & Thomas, K. R. (1990). Counseling Native Americans. *Journal of Counseling and Development, 69,* 128–133.

Higher Education Research Institute (2010). Degrees of success: Bachelor's degree completion rates among initial STEM majors. Los Angeles, CA: Author.

Hill, C., Corbett, C., & Rose, A.S. (2010). *Why so few? Women in science, technology, engineering, and mathematics.* Washington, DC: American Association of University Women.

Hoffman, L. L., Jackson, A. P., & Smith, S. A. (2005). Career barriers among Native American students living in reservations. *Journal of Career Development, 32*, 31-45.

Hoover, J. J., & Jacobs, C. C. (1992). A survey of American Indian college students: Perceptions toward their study skills/college life. *Journal of American Indian Education, 32,* 21-29.

Huang, G., Taddese, N., and Walter, E. (2000). *Entry and persistence of women and minorities in college science and engineering education* (NCES 2000-601). Washington, DC: National Center for Education Statistics, U.S. Department of Education.

Huff, D. J. (1997). *To live heroically: Institutional racism and Native American education.* Albany, NY: State University of New York Press.

Huffman, T. E. (1999). Cultural masks: Ethnic identity and American Indian higher education. Morgantown, WV: Stone Creek Press.

Huffman, T. (2001). Resistance theory and the transculturation hypothesis as explanations of college attrition and persistence among culturally traditionally American Indian students. *Journal of American Indian Education, 40*(3), 1-23.

Huffman, T. E., Sill, M., & Brokenleg, M. (1986). College achievement among Sioux and white South Dakota students. Journal of American Indian Education, 25(2), 32-38.

Hurtado, S., & Carter, D. F. (1996). Latino students' sense of belonging in the college community: Rethinking the concept of integration on campus. *College students: The evolving nature of research* (pp. 123-136). Needham Heights, MA: Simon & Schuster Custom Publishing.

Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L, & Espinosa, L. L. (2009). Diversifying science: Underrepresented students' experiences in structured research programs. *Research in Higher Education, 50,* 189-214.

Hurtado, S., Eagan, K. M., Cabrera, N. L., Lin, M. H., Park, J., & Lopez, M. (2008). Training future scientists: Predicting first-year minority student participation in health science research. *Research in Higher Education, 49,* 126-152.

Inkelas, K., Soldner, M., & Szelenyi, K. (2008). Living learning programs for first-year students. In W. Zeller (Ed.), *Residence life programs and the new student experience* (pp. 67-75). Columbia: University of South Carolina.

Inkelas, K., Szelenyi, K., Soldner, M., & Brower, A. M. (2007). The national study of living-learning programs: 2007 report of findings. Retrieved from http://hdl.handle.net/1903/8392

Jackson, P. W. (1968). The daily grind. In P.W. Jackson (Ed.), *Life in classrooms* (pp. 33-37). New York: Holt, Rinehart & Winston.

Jackson, A. P. & Smith, S. A. (2001). Postsecondary transitions among Navajo Indians. *Journal of American Indian Education, 40*(2), 28-47.

Jackson, A. P., Smith, S. A., & Hill, C. L. (2003). Academic persistence among Native American college students. *Journal of College Student Development, 44*(4), 548-565.

Johnson, D. R., Soldner, M., Leonard, J. B., Alvarez, P., Inkelas, K. K., Rowan-Kenyon, H., & Longerbeam, S. (2007). Examining a sense of belonging among first-year undergraduates from different racial/ethnic groups. *Journal of College Student Development, 48*(5), 525-542.

Jones, S. R., Torres, V., & Arminio, J. (2014). *Negotiating the complexities of qualitative research in higher education: Fundamental elements and issues* (2nd ed.). New York, NY: Routledge.

Keene, A. J. (2016). College pride, Native pride: A portrait of a culturally grounded precollege access program for American Indian, Alaska Native, and Native Hawaiian students. *Harvard Educational Review, 86*(1), 72-97.

Kirkness, V. J., & Barnhardt, R. (1991). First Nations and higher education: The four r's – respect, relevance, reciprocity, responsibility. *Journal of American Indian Education, 30*(3), 1-15.

Kokkelenberg, E.C., and Sinha, E. (2010). Who succeeds in STEM studies? An analysis of Binghamton University. *Economics of Education Review, 29*(6), 935-946.

Kovach, M. (2010). *Indigenous methodologies: Characteristics, conversations, and contexts.* Toronto, Canada: University of Toronto Press.

Larimore, J. A., & McClellan, G. S. (2005). Native American student retention in U.S. postsecondary education. *New Directions for Student Services, 109*, 17-32. doi: 10.1002/ss.150

Lee, J., Donlan, W., & Brown, E. F. (2010). American Indian/Alaskan Native undergraduate retention at predominantly white institutions: An elaboration of Tinto's theory of college student departure. *Journal of College Student Retention: Research, Theory and Practice, 12*(3), 257-276.

Lee Bitsoi, L., & Lowe, S. C. (2018). Journey into the sciences: Successful Native American STEM programs. In S. Waterman, S. Lowe & H. Shotton (Eds.), *Beyond access: Indigenizing programs for Native American student success* (pp. 87-106). Sterling, VA: Stylus Publishing LLC.

Leonard, S. E., Pearcy, B. M., Shehab, R. L., and Walden, S. E. (2013). Minority student informed retention strategies. Proceeding from IEEE '13: *IEEE Frontiers in Education Conference.* Oklahoma City, OK, pp. 567-573. doi: 10.1109/FIE.2013.6684887

Leslie, L. L., McClure, G. T., & Oaxaca, R. L. (1998). Women and minorities in science and engineering: A life sequence analysis. *Journal of Higher Education, 69,* 239-276.

Lin, R. L. (1985). The promise and the problems of the Native American student. *Journal of American Indian Education, 25*(1), 6–16.

Lin, R. L., LaCounte, D., & Eder, J. (1988). A study of Native American students in a predominantly white college. *Journal of American Indian Education, 27*(3), 8-15.

Lomawaima, K. T. (1999). The unnatural history of American Indian education. In K. G. Swisher, and J. W. Tippeconnic III (Eds.), *Next steps: Research and practice to advance Indian education* (pp. 1-31). Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools.

Lowe, S. C. (2005). This is who I am: Experience of Native American students. In M. J.

Tippeconnic Fox, S. C. Lowe, & G. S. McClellan (Eds), *New directions for student services: Serving Native American students* (pp. 33-40). San Francisco: Jossey-Bass.

Lundberg, C. A. (2014). Institutional support and interpersonal climate as predictors of learning for Native American students. *Journal of College Student Development, 55*(3), 263-277. doi: 10.1353/csd.2014.0027

Lundberg, C. A., & Lowe, S. C. (2016). Faculty as contributors for Native American students. *Journal of College Student Development, 57*(1), 3-17. doi: 10.1353/csd.2016.0003

Margolis, E., & Romero, M. (1998). "The department is very male, very white, very old, and very conservative:" The functioning of the hidden curriculum in graduate sociology departments. *Harvard Educational Review, 68*(1), 1-32.

Martin, S. C. & Thunder, A. L. (2013). Incorporating Native culture into student affairs. In H. J. Shotton, S. C. Lowe, S. J. Waterman (Eds.), *Beyond the asterisk: Understanding Native students in higher education* (pp. 39-51). Sterling, VA: Stylus Publishing, LLC.

Matsuda, M., Lawrence, C., Delgado, R., and Crenshaw, K. (Eds.) (1993). *Words that wound: Critical race theory, assaultive speech, and the first amendment.* Boulder, CO: Westview.

Mayes, T. (2014). Campus climate and the underrepresented minority engineering student experience: A critical race study (Doctoral dissertation). Retrieved from *ProQuest Dissertations and Theses.* (AAT 3639354)

McClellan, G., Tippeconnic Fox, & Lowe, S. M. J. (2005). Where we have been: A history of Native American higher education. *New Direction for Student Services,* 7-15.

McKie, S. (2019, June 18). EBCI one of first tribes to start AISES chapter. *Cherokee One Feather.* Retrieved from https://www.theonefeather.com/2019/06/ebci-one-of-first-tribes-to-start-aises-chapter/

McWhirter, E. H. (1997). Perceived barriers to education and career: Ethnic and gender differences. *Journal of Vocational Behavior, 50,* 124-140.

Miller, B. G. (2010). *Snow snakes and science agency: Empowering American Indian students through a culturally-based science, technology, engineering, and mathematics (STEM) curriculum* (Doctoral dissertation). Retrieved from ProQuest Dissertations Publishing. (UMI 3434291)

Milner IV, R. H. (2008). Race, culture, and researcher positionality: Working through dangers seen, unseen, and unforeseen. *Educational Researcher, 36*(7), 388-400. doi: 10.3102/0013189X07309471

Minthorn, R. S. & Nelson, C. A. (2018). Colonized and racist Indigenous campus tour. *Journal of Critical Scholarship on Higher Education and Student Affairs, 4*(1), 73-88.

Minthorn, R. S. & Shotton, H. J. (Eds.). (2018). *Reclaiming Indigenous research in higher education*. New Brunswick, NJ: Rutgers University Press.

Morrison, C., & Williams, L. E. (1993). Minority engineering programs: A case for institutional support. *NACME Research Newsletter, 4,* 1-11.

Musu-Gillette, L., Robinson, J., McFarland, J., KewalRamani, A., Zhang, A., & Wilkinson-Flicker, S. (2016). *Status and Trends in the Education of Racial and Ethics Groups 2016* (NCES 2016). Washington, DC: U.S. Department of Education, National Center of for Education Statistics.

Nathan, L. F (2017). *When grit isn't enough: A high school principal examines how poverty and inequality thwart the college-for-all promise.* Boston, MA: Beacon Press.

National Academy of Engineering. (2004). *The engineer of 2020—Visions of engineering in the new century.* Washington, D.C.: The National Academies Press.

National Academy of Engineering. Committee on Public Understanding of Engineering Messages. (2008). *Changing the conversation: Messages for improving public understanding of engineering.* Washington, DC: National Academy of Sciences.

National Academy of Engineering. (2006). *Engineering studies at tribal colleges and universities*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11582

National Center for Education Statistics (2017). *Certificates and degrees conferred by race/ethnicity*. Retrieved from https://nces.ed.gov/programs/coe/pdf/coe_svc.pdf

National Center for Education Statistics (2018, May). *Undergraduate enrollment.* Retrieved from https://nces.ed.gov/programs/coe/indicator_cha.asp

National Conference of State Legislatures. (2016, October 21). *National Indian country STEM effort and workforce development initiative.* Retrieved from http://www.ncsl.org/research/energy/indian-country-energy-and-infrastructure-working-group-iceiwg-3rd-quarter-meeting.aspx

National Conference of State Legislatures. (2018, November). *Federal and state recognized tribes.* Retrieved from http://www.ncsl.org/research/state-tribal-institute/list-of-federal-and-state-recognized-tribes.aspx

National Science Board. (2012). Science and engineering indicators 2012. Arlington, VA: National Science Foundation.

National Science Foundation. (2018). NSF awards new level of support for tribal colleges, establishes STEM centers. Retrieved from https://www.nsf.gov/news/news_summ.jsp?cntn_id=296661&WT.mc_id=USNSF_51&WT.mc_ev=click

National Science Foundation. (2017a). Bachelor's degrees awarded, by citizenship, ethnicity, race, sex, and field: 2014. Retrieved July 11, 2018, from https://www.nsf.gov/statistics/2017/nsf17310/static/data/tab5-7.pdf

National Science Foundation. (2017b). Undergraduate enrollment in engineering programs, by enrollment status, sex, race or ethnicity, and citizenship: 2003-13. Retrieved from https://www.nsf.gov/statistics/2017/nsf17310/static/data/tab2-9.pdf

Nelson, C. A. (2017, November 20). Moving away from data invisibility at tribal colleges and universities [Blog post]. Retrieved from https://www.higheredtoday.org/2017/11/20/moving-away-data-invisibility-tribal-colleges-universities/

Ozias, M. L. (2017). *White women doing racism: A critical narrative inquiry of white women's experiences of college* (Doctoral dissertation). Retrieved from https://shareok.org/handle/11244/51916

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research 66*(4), 543–578.

Peralto, L. N. (2014). Portrait. Mauna a Wākea: Hānau ka Mauna, the Piko of Our Ea. In N. Goodyear-Kaʻōpua, I. Hussey, and E. K. Wright (Eds.), *A nation rising: Hawaiian movements for life, land, and sovereignty* (pp. 232-245). Durham, NC: Duke University Press.

Perry, A. (2016, May 2). Black and brown boys don't need to learn 'grit,' they need schools to stop being racist. *The Hechinger Report.* Retrieved from https://hechingerreport.org/black-brown-boys-dont-need-learn-grit-need-schools-stop-racist/

President's Council of Advisors on Science and Technology. (2010). *Prepare and inspire: K-12 education in science, technology, engineering and math (STEM) for America's future* (Rep.). Retrieved from http://www.whitehouse.gov/ostp/pcast

President's Council of Advisors on Science and Technology. (2012). *Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics.* Washington, DC: Author.

Palmer, R. T., Maramba, D. C., & Dancy II, T. E. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *The Journal of Negro Education, 80*(4), 491-504. doi: 129.15.14.45

Perna, L.W., Gasman, M., Gary, S., Lundy-Wagner, V., & Drezner, N.D. (2010). Identifying strategies for increasing degree attainment in STEM: Lessons from minority-serving institutions. *New Directions for Institutional Research*, (148), 41-51. doi: 10.1002/ir.360

Pewewardy, C. (2013). Fancy war dancing on academe's glass ceiling: Supporting and increasing Indigenous faculty role models in higher education. In H. J. Shotton, S. C. Lowe, S. J. Waterman (Eds.), *Beyond the asterisk: Understanding Native students in higher education* (pp. 39-51). Sterling, VA: Stylus Publishing, LLC.

Pewewardy, C., & Frey, B. (2004). American Indian students' perceptions of racial climate, multicultural support services, and ethnic fraud at predominantly White universities. *Journal of American Indian Education, 43*(1), 32-60. Retrieved from http://www.jstor.org/stable/24398562

Poolaw, J. T. (2018). *Modern day warriors: An exploration of Indigenous male graduates* (Doctoral dissertation). Retrieved from https://hdl.handle.net/11244/299930

Querry, K. & Hill, P. (2014, April 10). *Oklahoma suburb named one of 'America's most dangerous suburbs*. Retrieved from *dangerous suburbs*. Retrieved from https://kfor.com/2014/04/10/oklahoma-suburb-named-one-of-americas-most-dangerous-suburbs/

Reyhner, J. & Eder, J. (2004). *American Indian education: A history.* Norman, OK: University of Oklahoma Press.

Robinson Kurpius, S. E., Payakkakom, A, Rayke, A. D., Chee, C., & Arredondo, P. (2008). The appropriateness of using three measures of self-beliefs with European American, Latino/a, and Native American college freshmen. *Journal of Multicultural Counseling and Development*, *36*, 2-14.

Rothwell, J. (2013). *The hidden STEM economy.* Washington, DC: Brookings. Retrieved July 27, 2018 from https://www.brookings.edu/research/the-hidden-stem-economy/

Schwandt, T. A. (2015). *The SAGE Dictionary of Qualitative Inquiry (4th ed.).* Thousand Oaks: Sage.

Scott, W. J. (1986). Attachment to Indian culture and the „difficult situation". Youth and Society, 17, 381-395.

Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press.

Shaw, E.J., and Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on STEM majors. *The National Academic Advising Association Journal, 30*(2), 19-34.

Shilling, R. (2015). *STEM education: A case for early learning.* Retrieved from http://innovation.ed.gov/2015/12/01/stem-education-a-case-for-early-learning/

Shotton, H. J., Lowe, S. C., & Waterman, S. J. (Eds.). (2013). *Beyond the asterisk: Understanding Native students in higher education*. Sterling, VA: Stylus Publishing, LLC.

Shotton, H. J., Oosahwee, E. S. L., & Cintron, R. (2007). Stories of success: Experiences of American Indian students in a peer-mentoring retention program. *The Review of Higher Education, 31*(1), 81-107. doi: 10.1353/rhe.2007.0060

Skouras, T. J. (1998). *Native American Indians and the counseling process: Culture, adaptation, and style*. (ERIC Document Reproduction Service No. ED 438114).

Smith, L. T. (2012). *Decolonizing methodologies: Research and Indigenous peoples* (2nd ed.) New Zealand: Otago University Press.

Smith, J. L., Metz, A., Cech, E., Hunatoon, M., & Moyer, C. (2014). Giving back or giving up: Native American student experiences in science and engineering. *Cultural Diversity and Ethnic Minority Psychology, 20*(3), 413-429. doi: 10.1037/a0036945

Smith, T. S. (1989). Ojibwe persons: Toward a phenomenology of an American Indian life-world. *Journal of Phenomenological Psychology, 20*, 130-144.

Strayhorn. T. L. (2008). *College students' sense of belonging: A key to educational success for all students.* New York: Routledge.

Strayhorn, T. L. (2010). Undergraduate research participation and STEM graduate degree aspirations among students of color. *New Directions for Institutional Research,* 148, 85-93. doi: 10.1002/ir.364

Sturm, C. (2009) Reflections on the anthropology of sovereignty and settler colonialism: Lessons from Native North America. *Cultural Anthropology, 32*(3), 340-348. doi: 10.14506/ca32.3.03

Tachine, A. R. (2015). *Monsters and weapons: Navajo students' stories on their journeys toward college* (Doctoral dissertation). Retrieved from ProQuest Dissertations Publishing. (UMI 3704874)

Tachine, A. E. (2019). Stifling the seedling's growth. *Insider Higher Ed.* Retrieved from https://www.insidehighered.com/advice/2019/08/02/thirty-meter-telescope-project-mauna-kea-raises-questions-about-academic-research#.XVl1TqgktQl.link

Tachine, A. & Begay, K. (2013). First-year experience for Native American freshman. In H. Shotton, S. Lowe & S. Waterman (Eds.) *Beyond the asterisk: Understanding Native students in higher education* (pp. 25-38). Sterling, VA: Stylus Publishing LLC.

Tachine, A. R., Yellow Bird, E., & Cabrera, N. L. (2016). An indigenous methodological approach for researching with groups of indigenous peoples. *International Review of Qualitative Research, 9*(3), 277-295.

Tierney, W. G. (1992). *Official encouragement, institutional discouragement: Minorities in academe-the Native American experience*. Norwood, NJ: Ablex Publishing Corporation.

Tierney, W. G. (1999). Models of minority college-going and retention: Cultural integrity versus cultural suicide. *Journal of Negro Education*, 80-91.

Tinto, V. (1987). Leaving college: Rethinking the causes and cures of student attrition. Chicago, IL: University of Chicago Press.

Tinto, V. (1993). Leaving college: Rethinking the causes and cures of student attrition. (2nd ed.). Chicago, IL: University of Chicago Press.

Tinto, V. (2006). Research and practice of student retention: What next? *Journal of College Student Retention, 8*(1), 1-19.

Traphagen, K. & Traill, S. (2014). How cross-sector collaborations are advancing STEM learning (Working Paper). Palo Alto, CA: Noyce Foundation. Retrieved from http://www.noycefdn.org/documents/STEM_ECOSYSTEMS_REPORT_140128.pdf

Tsui, L. (2007). Effective strategies to increase diversity in STEM fields: A review of the research literature. *The Journal of Negro Education, 76*(4), 555-581.

Tuck, E. & Wang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society, 1*(1), 1-40.

U.S. Census Bureau (2002). Current population reports: Population projections of the United States by age, sex, race, and Hispanic origin: 1995 to 2050. Table J, p. 13. Retrieved from https://www.census.gov/prod/1/pop/p25-1130.pdf

U.S. Census Bureau (2018). Annual estimates of the resident population by sex, age, race, and

Hispanic origin for the United States. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?eml=gd&pid=PEP_2015_PEPASR5H&prodType=table&utm_medium=email&utm_source=govdelivery

U.S. Department of Education, Office of Innovation and Improvement (2016). *STEM 2026: A vision for innovation in STEM education.* Retrieved from https://innovation.ed.gov/files/2016/09/AIR-STEM2026_Report_2016.pdf

U.S. Executive Office of the President. (2014, December). *Native youth report*. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/docs/20141129nativeyouthreport_final.pdf

van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy.* Ontario, Canada: Althouse Press.

Varma, R. (2009). Attracting Native Americans to computing. *Communication of the ACM, 52*(8), 137-140. doi: 10.1145/1536616.1536650

Vizenor, G. (1998). *Fugitive poses: Native American Indian scenes of absence and presence.* Lincoln: University of Nebraska Press.

Vizenor, G. (Ed.). (2008). *Survivance: Narratives of Native presence.* Lincoln, NE: University of Nebraska Press.

Volmert, A., Baran, M., Kendall-Taylor, N., & O'Neil, M. (2013). "You have the basics down really well": Mapping the gaps between expert and public understanding of STEM learning. Washington, DC: Frameworks Institute. Retrieved from

http://www.frameworksinstitute.org/assets/files/PDF_STEM/STEMMTG10-18-13_proofedandformatted.pdf

Warner, L. S. & Gipp, G. E. (Eds.) (2009). *Tradition and culture in the millennium: Tribal colleges and universities*. Charlotte, NC: Information Age Publishing.

Waterman, S. J. (2007). The Haudenosaunee college experience: A complex path to degree completion. *Journal of American Indian Education*, *46*(1), 20-40.

Waterman, S. J. (2011). Native American millennial college students. In F.A. Bonner, A.G. Marble, & M.F. Howard-Hamilton (Eds.), *Diverse millennial students in college: Implications for faculty and student affairs* (pp. 157-171). Sterling, VA: Stylus Publishing, LLC.

Waterman, S. J. (2012). Home-going as a strategy of success among Haudenosaunee college and university students. *Journal of Student Affairs Research and Practice*, *49*(2), 193-209.

Wells, R. N. (1997). The Native American experience in higher education: Turning around the cycle of failure II. Canton, NY: St. Lawrence University.

Wertz, F. J. (2005). Phenomenological research methods for counseling psychology. *Journal of Counseling Psychology, 52*(2), 167-177.

Wetsit, D. (1999). Effective counseling with American Indian students. In *Next Steps: Research and Practice to Advance Indian Education*. (ERIC Document Reproduction Service No. ED 427910).

White House Office of Science and Technology Policy (2016, February). STEM for all: Ensuring high-quality STEM education opportunities for all students. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/stem_fact_sheet_

2017_budget_final.pdf

Wilson, S. (2001). What is an Indigenous research methodology? *Canadian Journal of Native Education, 25*(2), 175-179.

Wilson, S. (2008). *Research is ceremony: Indigenous research methods.* Black Point, Nova Scotia: Fernwood Publishing.

Wolfe, P. (2006). Settler colonialism and the elimination of the native. *Journal of Genocide Research, 8*(4), 387-409. doi: 10.1080/1462352060105240

Woodford, B. (2005). *How to mentor graduate students*. Seattle, WA: University of Washington.

Yin, R. K. (2016). *Qualitative research from start to finish* (2nd ed.). New York, NY: The Guilford Press.

Youngbull, N. R. (2018). Moving beyond financial aid to support Native college students: An examination of the Gates Millenium Scholars program. In R. Minthorn & H. Shotton (Eds.) *Reclaiming Indigenous research in higher education* (pp. 124-145). New Brunswick, NJ: Rutgers University Press.

Appendices

Appendix A: Participant Recruitment E-mail

Dear students,

Osiyo! My name is Tiffany Smith, and I am a Ph.D. student in the Educational Leadership and Policy Studies department at the University of Oklahoma. I am Cherokee and am a citizen of the Cherokee Nation of Oklahoma. It is my honor to be reaching out to you.

In serving as a Native staff member at a four-year, public institution for the last 11 years in the engineering department, as well as serving as the AISES staff advisor for eight of those 11 years, I am passionate about creating more inclusive and supportive environments for our Native students. Hearing about your experiences as students at these mainstream institutions could be transformational for our academies, as well as for our future generations of Native students considering attending these institutions. As such, I have an opportunity for you to share with your students.

My study aims to learn from the experiences of Indigenous undergraduate students persisting in engineering programs at four-year, public non-Native colleges and universities (i.e. mainstream, predominantly white institutions). Consequently, I would like to invite you to participate this voluntary project. Your participation in the project includes a 10-15 minute phone conversation to get to know one another, answer any of your questions, and to hear from me on why this project is so important to our communities; a 1-2 hour conversation that will be scheduled on an individual basis via phone or Skype; and a reflective journal (not required) to add any additional thoughts (due one week later).

Please note that there will be no compensation for your time and this would be on a voluntary basis. However, know that your participation has a chance to leave a valuable impact on future generations of Indigenous students attending college and pursuing engineering for the betterment of our tribal communities.

If you are interested in participating, please respond to the provided email address or phone number listed below. **Please note that you will be required to sign the attached informed consent form prior to our conversation.**

Should you choose to participate, please know that your name will not be associated with your conversation and your identity will be kept strictly confidential, **unless you choose otherwise**. Participants will have an opportunity to choose their own pseudonym that may be meaningful to

them if they wish to remain anonymous.

Criteria for participation in this study are:

1. Students who identify as Indigenous, American Indian, Native American, Alaska Native, or Native Hawaiian.

2. Enrolled as an undergraduate student and are classified as a junior or senior, OR a graduate/alumnus within the last five years (2013-2018).

3. Must have a declared an engineering major or graduated with an engineering degree at your respective institution.

4. Must be enrolled or have graduated from a four-year, public, non-Native college or university.

5. Willing to be participate in 10-minute phone introduction, a 1-2 hour conversation via phone or Zoom, and a 10-30 minute reflective journaling exercise (not mandatory; due one week later).

I ask that you respond by **Friday, February 15, 2019.** If you should have any questions or concerns prior to considering participation, please e-mail, call or text me and we can set up a time to discuss at your convenience.

It is with open arms and an open heart that I thank you for considering participation. We need you to make this an impactful project. I hope to hear from some of you soon.

Wado,
Tiffany Smith
Ph.D. student, University of Oklahoma
(405) 760-1140 (cell) | tdsmith@ou.edu

Appendix B: Informed Consent

University of Oklahoma

Institutional Review Board

Signed Consent to Participate in Research

Would you like to be involved in research at the University of Oklahoma?

I am Tiffany Smith from the Department of Educational Policy and Leadership Studies and I invite you to participate in my research project entitled Indigenizing the Academy: A Story-Telling Journey to Determine Pathways for Native Student Success in Engineering. This research is being conducted at The University of Oklahoma. You were selected as a possible participant because you are a Native/Indigenous undergraduate student who is classified as a junior or senior as an engineering major, or who has graduated within the last five years from an undergraduate engineering program at a four-year public institution. You must be at least 18 years of age to participate in this study.

Please read this document and contact me to ask any questions that you may have BEFORE agreeing to take part in my research.

What is the purpose of this research? The purpose of this study is to understand the lived experiences of Indigenous students persisting in undergraduate engineering programs at non-Native colleges and universities.

How many participants will be in this research?

About 6-10 people will take part in this research.

What will I be asked to do?

If you agree to be in this research, you will participate in either a one-on-one conversation, and then complete a reflective journal due one week following the conversation.

How long will this take?

Your participation will take anywhere from 30-90 minutes.

What are the risks and/or benefits if I participate?

There are no risks and no benefits from being in this research.

Will I be compensated for participating?

You will not be compensated for your time and participation in this research.

Who will see my information?

In research reports, there will be no information that will make it possible to identify you. Research records will be stored securely and only approved researchers and the OU Institutional Review Board will have access to the records.

You have the right to access the research data that has been collected about you as a part of this research. However, you may not have access to this information until the entire research has completely finished and you consent to this temporary restriction.

Do I have to participate?

No. If you do not participate, you will not be penalized or lose benefits or services unrelated to the research. If you decide to participate, you don't have to answer any question and can stop participating at any time.

Will my identity be anonymous or confidential?

Your name will not be retained or linked with your responses unless you specifically agree to be identified. The data you provide will be retained in anonymous form unless you specifically agree for data retention or retention of contact information at the end of the research. Please check all of the options that you agree to:

I agree to being quoted directly. ___ Yes ___ No

I agree to have my name reported with quoted material. ___Yes ___ No

I agree for the researcher to use my data in future studies. ___Yes ___ No

Audio Recording of Research Activities

To assist with accurate recording of your responses, conversations may be recorded on an audio recording device. If you do not agree to audio-recording, you cannot participate in this research.

I consent to audio recording. ___Yes ___ No

Will I be contacted again?

The researcher would like to contact you again to gather additional information.

_____ I give my permission for the researcher to contact me in the future.

_____ I do not wish to be contacted by the researcher again.

Who do I contact with questions, concerns or complaints? If you have questions, concerns or complaints about the research or have experienced a research-related injury, contact me at (405) 760-1140 or tdsmith@ou.edu, or my advisor at (405) 325-1081 or derek.a.houston@ou.edu.

You can also contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu if you have questions about your rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than the researcher(s) or if you cannot reach the researcher(s).

You will be given a copy of this document for your records. By providing information to the researcher(s), I am agreeing to participate in this research.

Participant Signature	Print Name	Date
Signature of Researcher Obtaining Consent	Print Name	Date
Signature of Witness (if applicable)	Print Name	Date

Appendix C: Conversation Protocol

Title: Indigenizing the Academy: A Story-Telling Journey to Determine Pathways for Native Student Success in Engineering

Date:

Time of Conversation:

Duration:

Participant:

1. Tell me a little bit about yourself.
    a. What tribe (s) do you represent?
    b. Tell me about your family.
        i. Did your family participate in tribal ceremonies growing up?
        ii. Was your tribal language spoken at home?
    c. Describe where you grew up/your community.

2. Tell me about your journey to attend your institution. Describe what influenced your decision.

3. When did engineering become an attractive major to you? Tell me about memorable moment when you realized this was the career path for you.

4. How did you decide to enter into the program at your institution? How did you come to a final decision on which engineering major you chose? Tell me about any particular experiences that influenced these decisions.

5. Please share what your experience has been like so far in your engineering program. Do you have any experiences to share that have been particularly impactful to your persisting in engineering? Any experiences that have made you feel like you want to give up or do not belong?

6. Tell me what you have gotten involved (i.e. co-curricular activities) in while in school and what you have gained from being involved in these organizations. Do you have any stories to share that resonate with you?

7. Talk about what has contributed to your success thus far in your program. Feel free to share any (negative or positive) experiences that resonate with you.

8. Describe your post-college aspirations and why these are important to you.

9. Any words of advice you would tell future generations of Native students considering engineering?

10. Anything else you would like to add that you feel like you should have mentioned?

Researcher: Wado! Thank you so much for for sharing of your time and stories today. I will be in touch after collecting more data to have you review my findings to make sure I have truly gotten at the true meaning of your experiences you have so thoughtfully shared with me today. I will then share the transcripts with you for you to look over and offer any feedback.

Appendix D: Reflective Journal Protocol

Title: Indigenizing the Academy: A Story-Telling Journey to Determine Pathways for Native Student Success in Engineering

Conversation Date:

Date(s) of Journal:

Participant:

Due: Exactly one week following your conversation.

Instructions: Now that you have completed your conversation, please take some time to further reflect on your experiences in your engineering program. Use this journal in the week following your conversation to record any additional memories you may have about your educational experience, feelings that arose during or following your conversation, and/or any additional thoughts you may wish to share. Please include any information that you feel is important and may have been missed in the conversation.

Please fill in the information at the top of the instruction page, and use the pseudonym that I have provided you. Return your journal, along with the instruction sheet, to me in the provided pre-addressed and postage-paid envelope.

Wado! Thank you kindly for your participation!

Appendix E: Social Media Recruitment Flyer