ABSTRACT

Carolyn Veale, FROM IMPOSTER TO INNOVATOR: HOW UNDERREPRESENTED MINORITY STEM UNDERGRADUATE RESEARCHERS FORGE THEIR SCIENCE IDENTITY IN A HISTORICALLY WHITE SPACE (Under the direction of Dr. David Siegel) Department of Educational Leadership, May, 2025.

Despite considerable progress and extensive initiatives aimed at reducing disparities, significant gaps persist in the educational attainment of underrepresented minority (URM) students compared to their White and Asian counterparts. Research has demonstrated that undergraduate research participation, coupled with mentoring, enhances persistence in science, technology, engineering, and mathematics (STEM) fields and facilitates entry into graduate and doctoral programs. This study investigates the lived experiences of URM STEM students engaged in research at a historically White institution in the southern United States with a strong emphasis on STEM disciplines. Through narrative analysis, this research identifies recurring themes that illuminate students' experiences and highlight areas where additional support is needed. Furthermore, interventions designed to enhance undergraduate research engagement, strengthen science self-efficacy, and improve graduate school matriculation rates among URM STEM students were developed, implemented, and evaluated for effectiveness.

FROM IMPOSTER TO INNOVATOR: HOW UNDERREPRESENTED MINORITY STEM UNDERGRADUATE RESEARCHERS FORGE THEIR SCIENCE IDENTITY IN A HISTORICALLY WHITE SPACE

A Dissertation
Presented to the Faculty of the Department of Educational Leadership
East Carolina University

In Partial Fulfillment of the Requirements for the Degree
Doctor of Education in Educational Leadership

By
Carolyn P. Veale
May, 2025

Director of Dissertation, David Siegel, PhD
Dissertation Committee Members:
Crystal Chambers, PhD
Brandi Hinnant-Crawford, PhD
Travis Lewis, EdD

DEDICATION

This work is dedicated to my two beloved children, Deja Oliva Bryant and Daniel Albe Veale. Deja, you have been a constant part of this educational journey from the very beginning. Your unwavering belief in me gives me life. Through life's inevitable challenges, you remained my steadfast supporter, consistently reminding me never to doubt my intelligence or my ability to make a meaningful impact. It feels deeply fitting and profoundly special that I am completing this doctoral journey at the same time as you are achieving your Juris Doctor. I love you Deja.

To Daniel, you have borne witness to the relentless commitment and determination that your sister and I have poured into our goals over the years. I hope that watching two strong women persevere has shown you that no ambition is beyond your reach – that with dedication, you too can accomplish anything you set your mind to. Keep dreaming. I love you Daniel.

To my mother, Albertia Cherry Veale, and my father, James Otis Veale Sr. – though neither of you had the opportunity to complete high school, you instilled in me the value of education. While you are no longer here to witness this moment, I carry your love, sacrifice, and teachings with me every single day. I love you Mom and Dad.

To my sister, Chelsea – losing you in 2021 changed my life forever. Your love, encouragement, and presence are etched into my heart, and I will continue to carry you with me always. I promise to keep writing to you about all my journeys, as I know you are still watching over me. I love you Baby Sister.

To my siblings, Donte and James Jr., thank you for your unwavering love and support. Donte, your investment in me during my undergraduate years will never be forgotten. I love you.

This dissertation stands as a tribute to my family's legacy, resilience, and to the enduring power of love, belief, and shared dreams. Delayed but not denied.

ACKNOWLEDGEMENTS

This dissertation has been a challenging and rewarding undertaking that involves my tribe, a community of people who have supported and rallied behind me. I am profoundly grateful to my chair Dr. David Siegel, for his unrelenting encouragement, guidance, and support. My sincerest appreciation to my committee members, Dr. Crystal Chambers (we started this journey a while ago), Dr. Brandi-Hinnant (my former student and now the consummate educator and researcher), Dr. Travis Lewis (a supporter to so many students) and former committee member, Dr. Roshaunda Breeden.

To the NC State University T34 students who participated in this study, I am thankful for your willingness to share your research lives with me. This research would not have been possible without your contributions. I am appreciative of the National Institute of Health (NIH) for recognizing and appreciating the importance of diversity. To the Comparative Medicine Institute partners and the University Honors Program partners at NC State University- thank you for giving me the space to do the work.

Again, a heartfelt thank you to my children Deja, and Daniel and “the dog” Kaepernick for always being there. A sincere thank you to my other family members who have given me words of encouragement throughout this process. To Ms. Susan Grant – I will never forget your support and your willingness to read every single word of this research study and give feedback. To my cohort bestie Stacia, I appreciate you so much. To my good friends who have listened to me vent about this labor of love, Casey, Gregg, and Valerie, thanks for your friendship and willingness to stand in the gap around the clock. This dissertation is a testament to the constant love and support I receive from so many people – my tribe. I am truly blessed to have had the support of many named and unnamed people throughout this amazing journey.

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CHAPTER 1: INTRODUCTION

The North Carolina State University 2022 Chancellor's Report indicated that the university surpassed $500 million in annual research expenditures and is ranked sixth in research spending among public universities without a medical school (NC State Chancellor's Annual Report, 2022). The report states that the research achievements, along with other accolades, are the steppingstones to moving NC State forward as the university grows in quality, impact, and reputation. While having a robust research agenda is a true institutional benefit, not all students are capitalizing on the opportunities to engage in research. There continues to be a disparity of underrepresented minority (URM) science, technology, engineering, and math (STEM) students in the science community (Capri et al., 2017; Chang et al., 2014; Eagan et al., 2013; Gibau 2015).

Underrepresented minorities include individuals of races or ethnicities whose representation in STEM employment and S&E (science and engineering) education is smaller than their representation in the U.S. population. This includes Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives (Diversity and STEM: Women, Minorities, and Persons with Disabilities, 2023). In the 2019 National Institute of Health (NIH) Interest of Diversity publication URM groups included individuals from underrepresented racial and ethnic groups, individuals with disabilities, individuals from disadvantaged backgrounds, and women.

Disparities in the STEM fields, as it relates to undergraduate research, degree attainment, and the pursuit of graduate degrees are often a result of the manifestation of inequalities in higher education (Figueroa & Hurtado, 2013; Whitcomb & Singh, 2021). URM students are subjected to historically rooted inequities when pursuing an education especially in STEM disciplines with

little diversity (Whitcomb & Singh, 2021). Specialized programs supported by organizations like the National Institute of Health (NIH) and the National Science Foundation (NSF) have dedicated significant resources to address inequities such as financial support, research experience, and mentoring that can be challenges for URM STEM students (U.S. Department of Health and Human Services, n.d.b.). While these programs try to address issues of disparity (e.g., lack of mentorship, lack of funding, etc.) and strides have been made, URM STEM students still lag White students as it relates to undergraduate research engagement and advanced degree attainment (Estrada et al., 2017; Hansen et al., 2023; Metzger et al., 2023). URM STEM students in the United States, for example, start college with the same level of interest in STEM majors as their overrepresented peers, but six-year STEM completion rates drop from 52% for Asian Americans and 43% Caucasians to 22% for African Americans, 29% Latinx, and 25% for Native Americans (Theobald et al., 2020).

Statistics indicate URM STEM undergraduate students are not performing undergraduate research at the rate of White students. Based on the current undergraduate research engagement literature, varying factors from preparation to campus environment have been cited as reasons that URM students do not pursue undergraduate research (Bruthers et al., 2021; Chang et al., 2014). While some studies have pointed to the dwindling numbers of URM STEM students in undergraduate research, many campuses are still unaware of the magnitude of the day-to-day problems faced by URM students, particularly at Historically White Institutions (HWIs) (Hurd et al., 2016; Hurtado & Ruiz, 2012; Loeb et al., 2019). URM STEM undergraduates come into higher education with a strong interest in research and aspirations to obtain a graduate education and more than half of these students express a clear desire to find cures to persistent health problems (Hurtado et al., 2010).

There have been subtle shifts in URM students going on to pursue advanced degrees, but there is still a significant gap between URMs pursuing advanced degrees in STEM fields in comparison to White and Asian students (Carpi et al., 2017; Chang et al., 2014; Eagan et al., 2013). Understanding URM STEM students and the challenges they can often face in historically White spaces can better equip higher education administrators with the knowledge to address some of the issues that continue to widen the gap. Achievement gaps between overrepresented and underrepresented students have been called one of the most urgent and intractable problems in higher education (Theobald et al., 2020).

This study explores and examines the narratives of URM STEM undergraduates who are engaging in undergraduate research and have shown an interest in graduate school. Understanding their stories will potentially provide URM STEM undergraduates, administrators, principal investigators, and stakeholders with additional information to help retain URM students in STEM undergraduate research programs, graduate programs, and ultimately science careers. The knowledge gathered from research data will be used to develop an intervention to support URM STEM students and their research agendas and educate those who engage with URM STEM students. Whether the intervention should be directed toward URM STEM students or administrators, or both is yet to be determined. The data that is uncovered through the in-depth interviews will guide the intervention.

This chapter will provide background information pertaining to the underrepresentation of URM students engaging in undergraduate research at HWIs, the context of the study, the focus of the study, the questions guiding the research, an overview of the inquiry, the inquiry partners, the theoretical framework that will guide the study, definition of key terms, assumptions, scopes and delimitations, limitations, the significance of the inquiry, addressing how this study will

advance equity and social justices, how this study will advance the practice, and end with a summary.

Background of Focus of Practice (FoP)

Over the past few years, I have worked very closely with high-achieving URM STEM students engaged in biomedical research. These students have been recruited for a National Institute of Health (NIH) program (T34) targeted at URM STEM students interested in pursuing a PhD or /PhD in the biomedical field. While the program has had some success, there seems to be a commonality as it relates to the mentoring aspect of the undergraduate research experience. There have been a few accounts where the URM STEM student had to identify another research project/space to conduct their research because the research space in which they were in became toxic and unmanageable. This was due in part to issues surrounding the mentor. Examples regarding issues with mentors include: a graduate level mentor telling a URM STEM female student underrepresentation in certain STEM fields is just an excuse for women and Black people to be lazy to a graduate level mentor making unwanted advances at a URM STEM female student. Programs such as the T34 should be programs that support and strengthen the science self-efficacy of URM STEM students engaged in undergraduate research and in some instances, it has the opposite effect.

Programs like the T34 program are in place to enhance the undergraduate research training of individuals from groups underrepresented in certain STEM fields in preparation for the URM student going on to pursue a research doctorate degree program. The mentoring aspect of these programs is a crucial component. It is important to organizations like the National Institute of Health (NIH) and National Science Foundation (NSF), the institutions that deliver these grants, and the STEM field in general (stakeholders), know that those who are in place to

support these efforts understand the assignment. Key theoretical attributes of successful mentoring relationships include developing research skills and self-efficacy, building trusting relationships, developing science identity, and belonging, advancing equity and inclusion, fostering independence, and actively advocating for mentees (Pfund et al., 2016).

Educational attainment is the goal of so many people in the United States and URMs (Underrepresented Minority) are no exception. Obtaining an undergraduate degree certainly puts individuals at an advantage as it relates to quality of life and income potential. Employment in STEM has a positive impact on earning potential. Median wage and salary earnings are higher for those working in STEM than in non-STEM occupations, regardless of sex, race, ethnicity, or disability status (Diversity and STEM: Women, Minorities, and Persons with Disabilities, 2023).

Despite substantial advances and extensive efforts to bridge the divide, significant gaps still exist between the educational attainment of URM and their White and Asian peers, particularly in STEM fields (Carpi et al., 2017). Underrepresentation of racial/ethnic minorities in STEM careers is not necessarily attributable to a lack of interest in science fields, but poor science degree completion rates (Estrada et al., 2016; Toven-Lindsey et al., 2015). There are many factors and barriers to uncover to garner an in-depth understanding of URM students in STEM at HWIs and their undergraduate research experiences that potentially affects their persistence and advances their matriculation to graduate programs.

Economic Competitiveness

Achievement gaps increase income inequality and decrease workplace diversity by contributing to the attrition of underrepresented students from STEM majors (Theobald et al., 2020). It is a critical national priority to develop, recruit, and keep talent in STEM fields to maintain the U.S.'s economic competitiveness in the context of rapid globalization (Hurtado et

al., 2011). Diversity in the workforce allows for innovation by leveraging differing backgrounds, experiences, and viewpoints. Innovation and creativity, along with technical skills relying on STEM expertise contribute to a robust STEM enterprise (National Center for Science and Engineering Statistics, 2023).

Students in the US are behind other nations on international assessments of science, mathematics, and problem-solving ability. The achievement gap is disproportionately observed in minority and disadvantaged populations, and the overall trend raises concerns that the nation could lose its edge in science and technological innovation (Theobald et al., 2020).

Undergraduate Research

Undergraduate research programs socialize students by connecting them with faculty and advanced peers who provide undergraduates with access to professional networks and new sources of information, and broader access to institutional resources and networks improves students' capacity to navigate educational systems (Eagan et al., 2013). Having a strong undergraduate research portfolio and positive research experience can aid in the transition to a graduate-level program in the STEM field. Participation in research at the undergraduate level has become an increasingly required activity to gain access to merit-based scholarships and awards, acceptance into graduate school, and competitive career opportunities (Haeger & Fresquez, 2016).

Undergraduate research is an inquiry or investigation conducted by an undergraduate that makes an original, intellectual, or creative contribution to the discipline (Wenzell, 1997). Undergraduate research falls under both the category of engaged student learning and high-impact practices (HIPs). For over a decade, Kuh's (2008) work on the critical importance of engaged learning has shaped the undergraduate college and university experience. URM

students' participation rate in HIPs also lags that of White students (White et al., 2018). There is a growing body of research (Bhattacharyya & Chan, 2021; Finley & McNair, 2013; Kilgo et al., 2015; Kinzie, 2019; Ndoye, 2023; Quaye & Harper, 2014) that points out the importance of HIPs like undergraduate research, and the benefits for the entire academic community, including the institution, the student, and the faculty/staff; however, there are barriers that prohibit the pursuance of these opportunities for URM students, which ultimately may impact their persistence to graduate school (Eakins & Eakins, 2017). URM students interested in undergraduate research can be hesitant to seek opportunities, can struggle once in research settings, or drop out prematurely due to the culture that exists in some research settings (Capri et al., 2017; Chang et al., 2014).

URM Discrimination at HWIs

Aside from lack of undergraduate research opportunities, many URM students also experience discrimination and bias, but most of these incidents go unreported (Hurtado & Alvarado, 2015). Unconscious bias, microaggressions, stereotypes, social isolation, and imposter syndrome are all barriers that researchers have historically associated with the experiences of URM undergraduate students at HWIs. Surveys of college students indicate that race is still a significant issue and that the underrepresentation of Black, Latinx, and Native American students serves to reinforce stereotyping and discrimination in college environments (Hurtado & Ruiz, 2012). If one of the key purposes of higher education is to prepare students for engagement in a diverse democracy, educators and policymakers must understand the conditions under which students' academic and civic learning can be facilitated or hindered (Hurtado & Ruiz, 2012).

Significance of Diversity

A growing body of research has focused on the benefits of diversity shows that research teams composed of people from a variety of backgrounds and experiences produce better and more innovative products and ideas than a homogeneous team (Smith & Schonfeld, 2000; Turner, 2013). Many campuses have begun to realize the benefits of diverse learning environments by working to improve intergroup relations on campus, acknowledging that some degree of discrimination and bias on campus is likely to occur when individuals are unfamiliar with the culture, backgrounds, and worldview of others (Hurtado & Alvarado, 2015). Students from diverse groups offer new perspectives and raise new questions; institutional policies fostering diversity enhance the cognitive development, satisfaction, and leadership abilities of students; students who interact with diverse peers in and out of the classroom show increased critical thinking, intellectual engagement, and growth in academic skills. The U.S. global leadership in STEM is dependent on diversity, leveraging diverse backgrounds and points of view to bring diverse insight to problem solving and discovery (National Center for Science and Engineering Statistics, 2023). Having a better understanding of how URM STEM students navigate STEM engagement is imperative in supporting URM students and leveling the playing field in higher education.

Context of Study

This study is situated at North Carolina State University, also abbreviated as NC State University. NC State University in Raleigh is a higher education institution located in Wake County, NC. NC State University has a current enrollment of 37,873 undergraduate and graduate students. Of that number, 25,312 are seeking bachelor's degrees; 5,899 master's degrees; 3,667 doctoral degrees; and 339 Doctor of Veterinary Medicine (NC State University Admissions, 2023). Of the over 37,873, 49% are female and 51% are male with 79% identifying as North

Carolina (NC) residents and 21% being from other states outside of NC. The undergraduate race/ethnicity makeup at NC State University for fall 2021 is as follows: the total enrollment – 36,831 - American Indian – 0%; Asian – 8%; Black or African American – 6%; Hispanic/Latino - 7%; Native Hawaiian or other – 0%; White – 67% Two or more races – 4%; Race/ethnicity unknown – 3%; Non-resident alien – 3%. Institutional data from the 2021-2022 academic year indicate that 10,254 degrees were awarded including: Agricultural Institute (113); Bachelors (6,524); Masters (2,344); Doctoral (569); Doctor of Veterinary Medicine (DVM) (104); Undergrad certificates (85); Graduate Certificates (515). NC State has a six-year graduation rate of 85.8%.

NC State University has 2,463 faculty members and 6,985 staff members. The university has 844 full professors, 505 associate professors, 546 assistant professors, 348 lecturers, 139 field faculty, and eighty librarians. Faculty types include 1,094 tenured faculty, 334 tenure track, 997 professional, and thirty-eight phased retirement. Of all the faculty, 89.4% are full-time; and 10.6% are part-time. In terms of gender, 41.5% of faculty are female and 58.5% are male. Of NC State staff, 99.2% are full-time and less than 1% part-time and of those numbers, 55% are female and 45% male. The total number of NC State student workers is 3,363.

In 2021, 10,643 degrees were awarded across all undergraduate and graduate programs. 47.8% of these degrees were awarded to women, and 52.2% were awarded to men. The most common race/ethnicity group of degree recipients was White (6,533 degrees), 91.9% more than the next closest race/ethnicity group, Asian (711 degrees). NC State University has $546 million in annual research expenditures. NC State University is No. 6 in research spending among public universities without a medical school. The university has a $1.95 billion endowment, is among

the top ninety largest higher-education endowments in the country and has a $1.84 billion budget for fiscal year 2022.

NC State University mission statement reads: “As a research-extensive land-grant university, North Carolina State University is dedicated to excellent teaching, the creation and application of knowledge, and engagement with public and private partners. By uniting our strength in science and technology, with a commitment to excellence in a comprehensive range of disciplines, NC State promotes an integrated approach to problem-solving that transforms lives and provides leadership for social, economic, and technological development across North Carolina and around the world” (NC State Institutional Strategy and Analysis, 2023).

Statement of Focus of Practice (FoP)

Obtaining a college degree, transitioning into graduate and professional schools, and/or entering a professional career continues to pose a struggle for STEM URMs at HWIs and NC State University is no exception. Research has established that experiences of discrimination negatively affect a sense of belonging and retention, even among the most high-achieving Black and Latinx students (Hurtado & Alvarado, 2015), particularly those in STEM. There are barriers that URM STEM students face that negatively impact their pursuance of these opportunities. Specifically, scholars indicate that Black students have significantly lower odds of participating in health science research in the first year of college compared to their White counterparts (Hurtado et al., 2010). This study investigates the experiences of URM students in STEM pursuing research at a HWI (Historically White Institutions) with high research activity.

URM STEM students who do engage in undergraduate research can struggle and drop out prematurely due to the research culture that exists in some institutional research settings. We can assume there are success stories of underrepresented students engaging in positive

undergraduate research experiences that affect their professional, research, and academic trajectory. Developing a standard in which underrepresented students are pursuing undergraduate research at a percentage rate that outweighs their enrollment rate can have a positive impact on programs and institutions. What can institutions do to attract underrepresented students to research? What type of climate can be fostered in which undergraduate students feel welcomed and supported to pursue these opportunities? What does success look like for underrepresented students pursuing undergraduate research? It is important to understand the lived experiences of underrepresented students pursuing and engaging in undergraduate research at HWIs. Understanding the narratives of underrepresented students who consider and engage in research opportunities will move programs and institutions to a level of competence that can aid in recruitment initiatives, mentoring, and the overall research culture. This research will explore and examine the narratives of URM STEM undergraduates engaged in undergraduate research.

The focus of this inquiry is to explore and examine the lived experiences of URM STEM students engaging in undergraduate research at NC State University. The goal of this examination is to uncover data that will support the development and implementation of an intervention to better support their research experience and address the barriers and challenges on a micro level. While engaging with URM STEM students has been a significant part of my action space for the past few years, students do not have a true understanding of what may be happening in the research setting is not fully understood. Something is preventing some URM STEM students from capitalizing on the undergraduate research experience. Some of the brightest URM STEM students that engage in research at NC State University encounter situations that either cause them to pause in their path to attain a graduate degree or have them considering changing their STEM academic path altogether.

Support mechanisms that are intended to eliminate barriers and build self-efficacy are falling short. The narratives of URM STEM students will hopefully shed light on what is occurring in these research settings. The stories of URM STEM students will be collected and analyzed for any themes that may further define their experiences. Education research requires the collection, analysis, and interpretation of data as a means of answering the inherent question or problem under investigation (Mertler, 2022).

FoP Guiding Questions

The research questions guiding this inquiry are:

- RQ1. What are the lived experiences of underrepresented minority (URM) STEM students engaging in undergraduate research at NC State University, and how do these lived experiences play out in academics, graduate school aspirations, and career choice behaviors?
- RQ2. What are the barriers and challenges to achievement for URM STEM students engaging in undergraduate research, and what can be done to address these barriers and challenges?
- RQ3. What programmatic efforts can be identified and implemented to mitigate the challenges and support underrepresented minority (URM) students engaging in undergraduate research?

Overview of Inquiry

This study explores and examines the narratives of URM STEM undergraduates engaging in research. The study seeks to understand URM STEM students' engagement in undergraduate research at NC State University. A narrative research approach will be used to explore, examine, and describe the lived experiences of URM STEM students. URM STEM

students engaging in the T34 program will be invited to participate in individual interviews to discuss their undergraduate research experience. The clear advantage of narrative research is its ability to focus in detail on the events of an individual's life, to tie events together, examine relationships, and offer explanation and insight into that life within its specific context (Mertler, 2022).

Narrative inquiry is a qualitative method that explores the experiences of a targeted population (Creswell, 2013). As a qualitative methodology, narrative inquiry is appropriate for exploring the experiences of a population that has thus far been understudied, whose voices are lacking in previous research, and who need to be empowered to share their stories (Creswell, 2013). The use of in-depth interviews will allow me to gather in-depth information about the everyday lived experiences of underrepresented students (Denzin & Lincoln, 2000). Narrative research involves collecting stories from individuals about their lived experiences that are simultaneously unique and universal (Kim, 2016).

This research study will involve three phases. Phase I of this research study will involve a reflection of my involvement as an administrator of a program designed for high-achieving URM STEM students engaged in biomedical research and in-depth interviews with URM STEM students engaging in undergraduate research at NC State University through the T34 program. The information that is gathered through the interviews and prior knowledge of undergraduate research programs will lead to the development and implementation of an intervention designed to enrich the undergraduate research experience, eliminate and/or lessen the impact of perceived barriers and foster an environment in which their science self-efficacy is actualized.

Phase II will involve using my experience as an administrator working with URM STEM students engaging in undergraduate research, engaging with inquiry partners as it relates to their

experiences, reviewing interventions that support URM STEM students in historically White spaces, and continuing to thoroughly analyze the in-depth interviews for recurring themes as it relates to the lived experiences as well as the barriers and challenges that URM STEM students encounter in undergraduate research. The intervention developed and implemented will address the barriers and hindrances that were uncovered through the findings of the interviews, my knowledge as an administrator, and the review of successful programs that have supported URM STEM students in historically White spaces.

Phase III will examine the intervention and follow up with the URM students to understand the program intervention impact and significance as it relates to their undergraduate research experience. Educational research should be conducted so the results prove beneficial to someone, somewhere, somehow, or someday (Mertler, 2022).

Inquiry Partners

NC State University has multiple entities on campus that engage in the research and scholarship mission of the university which includes diversity, equity, inclusion, and belonging initiatives. While these multiple entities exist there does not appear to be a singular voice that has emerged to make sense of the gap that exists between URM STEM students and White students engaging in undergraduate research, therefore a diverse group of inquiry partners will help guide this work.

My inquiry partners include members of the NC State University campus community who work closely with URM STEM students who are conducting undergraduate research. This includes the University Honors Program; the Office of Undergraduate Research; the Comparative Medicine Institute; STEM multicultural special programs (TRIO and McNair Scholars Programs); the WISE (Women in Science and Engineering) and Black Male Initiative

Villages, and the Office for Institutional Equity and Diversity. I will also utilize resources that have already been established by the National Institute of Health as it relates to studying URM STEM students and undergraduate research.

Theoretical Framework

Working with URM STEM students engaging in undergraduate research has been a part of my professional engagement over the past few years. I have witnessed the successful navigation of URM STEM students in the research space as well as the struggles that they endure. The goal of many programs that are designed to support URM STEM students in undergraduate research is to support the building of their research agenda, support their science identity formation, and prepare them for graduate school. My study is intended to shed light on their experiences and devise an intervention to further support their research endeavors. I want to approach this research with an open mind and not allow my prior knowledge to impact the findings. In identifying a theoretical framework to guide this study I want to loosely apply the theory to guide the study.

Bandura's Theory of Self-Efficacy will guide the development of the in-depth interview questions and guide me in understanding what may be happening in the research setting as it relates to URM STEM students' science identity formation. There may be other theoretical frameworks that will further support and guide Phase II and Phase III of the study once the data gathered from Phase I is examined.

Research educators employing experiential teaching strategies may feel affirmed in learning that performance accomplishments comprise the most dependable and potent source of efficacy information (Bandura, 1981; 1986). Extrapolating further from Bandura's theory, students' beliefs about their research competencies can be expected to influence (1) the number

and type of research-related activities initiated, (2) the level of effort invested in research endeavors undertaken, and (3) the persistence exhibited in their attempts to master research content, especially when difficulties are encountered (Montcalm, 1999).

Behaviorally, people's convictions concerning their own competence are expected to affect not only the types of situations they enter, but also what, if any, coping strategies they attempt (Montcalm, 1999). Bandura (1981) states, "People tend to avoid situations they believe exceed their capabilities, but they undertake and perform with assurance activities they judge themselves capable of handling" (p. 201).

Developing an understanding of the science identity development for students of color is essential because it helps construct a connection to the belief that science has value and that the student is capable to engage in the sciences successfully (Flowers et al., 2016). Science self-efficacy involves a student embracing their ability to perform in the science discipline. Self-efficacy is the belief that one can approach a challenge and execute the actions necessary to achieve the desired outcome (Bandura, 1977).

Perceived self-efficacy was introduced by Bandura (1977) as "an integrative theoretical framework to explain and predict psychological changes achieved by different modes of treatment" (p. 191). Self-efficacy is concerned with personal judgements about how well one can execute the cognitive, social, and behavioral skills required to deal with upcoming situations (Bandura, 1981). Individuals' perceptions of their abilities also influence the thought processes and emotional responses that occur as they anticipate what and with the environment (Bandura, 1981). In applying Bandura's perspective to students' pursuit of research competency, the concept of research self-efficacy (i.e., judgements students hold about their ability to manage research-related tasks) becomes particularly important (Montcalm, 1999).

Self-efficacy beliefs are assumed to form our primary sources of information: personal performance accomplishments, vicarious experiences (e.g., observing similar others), social persuasion, and physiological and emotional states. Personal accomplishments (successes and failures with specific tasks) are assumed to offer a particularly compelling source of efficacy information, but the nature of the social models and reinforcing messages to which one is exposed, and the types of physiological states one experience while engaged in particular tasks (e.g., low levels of anxiety), can all affect one's self-efficacy regarding different performance domains.

Definition of Key Terms

The following list of key terms will provide clarity for the purposes of this study:

Unconscious bias - Unconscious bias are social stereotypes about certain groups of people that individuals form outside of their own conscious awareness. Bias is not limited to ethnicity and race. Bias can exist towards any social group (Fiarman, 2016).

Microaggressions - Microaggressions are everyday verbal, nonverbal, and environmental slights, snubs, or insults, whether intentional or unintentional, which communicate hostile, derogatory messages to target persons based solely upon their marginalized group membership (Sue et al., 2007).

Stereotype threat - A stereotype threat is a situational predicament in which people are or feel themselves to be at risk of conforming to stereotypes about their social group (Steele, 1997).

Social isolation - Social isolation is a lack of social connections. Social isolation can lead to loneliness in some people, while others can feel lonely without socially isolating. A state in which the individual lacks a sense of belonging socially, lacks engagement with others, has a

minimal number of social contacts, and they are deficient in fulfilling quality relationships (Shvedko et al., 2018).

Code switching - Code-switching is adopting a dual identity to fit into a particular space. It is often considered a survival tactic and can happen across any social identity (Washington-Harmon, 2022).

Imposter syndrome - These individuals cannot internalize their success and subsequently experience pervasive feelings of self-doubt, anxiety, depression, and/or apprehension of being exposed as a fraud in their work, despite verifiable and objective evidence of their successfulness (Bravata et al., 2020).

Self-efficacy beliefs - Self-efficacy beliefs are assumed to form our primary sources of information: personal performance accomplishments, vicarious experiences (e.g., observing similar others), social persuasion, and physiological and emotional states (Bandura, 1981; 1987).

Underrepresented minority (URM) – a group that include women, person with disabilities, and specific racial and ethnic minorities – namely, Black or African American, Hispanic or Latino, and American Indian or Alaska Native individuals. These groups are considered underrepresented because their participation in S&E education and employment is smaller than their representation in the U.S. population. Persons from disadvantaged socio-economic backgrounds are also included in the definition (NCSES, 2023).

Disadvantaged – a set of socioeconomic, educational, and environmental factors that hinder an individual's access to opportunities, resources, and social mobility. Organizations such as the National Institutes of Health (NIH) and the National Science Foundation (NSF) define disadvantaged individuals as those who have faced systemic barriers due to poverty, lack of access to quality education, underrepresentation in higher education and professional fields, or

adverse living conditions. May meet criteria such as eligibility for federal assistance programs (e.g., Pell Grants, free or reduced lunch), growing up in a low-income or rural area, or being part of a historically underrepresented group in higher education and STEM fields (NIH, 2019).

Assumptions

Regarding the URM STEM participants in this study, there is an assumption that they will be willing to provide honest responses as it pertains to their lived experiences in undergraduate research. The participants will be provided with consent documentation to ensure that their participation is voluntary, and their responses kept confidential.

Scope and Delimitations

This research will take place at NC State University, a Research I, large public, land-grant institution. This study will focus on the lived experiences of URM STEM students engaging in undergraduate research. URM students will continue to attend HWIs across the nation. HWIs will continue to have undergraduate research experiences on their respective campuses. Extending this research outside of STEM majors and their pursuit of undergraduate research could shed some light on other disciplines and what is occurring in those research settings.

Limitations

This study will explore the experiences of URM students at one HWI (NC State University). Due to factors, skills, and characteristics that are often needed for URM STEM students engaging in research (e.g., competitive GPA >3.0, advanced undergraduate coursework, and earning good grades in STEM coursework) the narratives of these students may be different for a student who is just beginning to engage the STEM discipline or struggling in their major. This may impact the narrative and not give the full picture of URM STEM students who desire

to engage in undergraduate research. As a result, the current study may not be generalizable to URM students majoring in STEM who desire to engage in undergraduate research and attend graduate school.

Significance of Inquiry

Many universities and programs like honors programs and offices of undergraduate research are invested in students maximizing their experience while putting themselves in a position to have an even greater impact on society beyond their undergraduate education. Most institutions can benefit from actively reshaping their culture of science on campus to balance rigor and support in ways that better acquaint students with the empowering and collaborative side of scientific discovery (Hurtado et al., 2007).

Having a better understanding of what URM STEM students experience while engaging in undergraduate research at HWIs can potentially help stakeholders identify additional resources that could potentially support these students developing a strong science identity. Colleges and programs that can affirm students' identities and provide opportunities for success in science may go a long way to ensure that students are prepared for the challenges in diversifying the workforce in the future (Hurtado et al., 2012).

The increased level of knowledge can aid in recruitment initiatives, mentoring, and improving the overall research culture. Having rich research data will better aid administrators, faculty, and research mentors to understand the everyday issues that URM STEM students face and hopefully bring all of us who serve URM students to a level of competence to better support these students in their overall educational endeavors.

Professional opportunities in STEM will continue to grow, and undergraduate research can be a key source relating to URM students navigating STEM fields of study. Understanding

their stories could lead to reimagining undergraduate research for the URM students in the hope of drawing more interest and leveling the playing field by addressing the barriers that exist at HWIs. Underrepresented students will continue to be grossly underrepresented if issues surrounding the barriers to engaging in undergraduate research are not fully addressed. This underrepresentation will affect URM students' entry into graduate and professional programs on a national scale. Lagging in professional opportunities will further widen the wage gap that exists for underrepresented people.

Advancing Equity and Social Justice

This research will seek to understand the narratives of URM STEM students and explore their research experiences to better understand the gap that continues to exist between URM STEM students and well represented students engaging in research at NC State University. Having a positive undergraduate research experience can certainly affect URM STEM students' desire to pursue a graduate level education and increasing diversity in this area will surely lend itself to confronting some of the health care disparities that exist globally.

Advances in Practice

Having positive undergraduate research experience can certainly impact the science self-efficacy of URM STEM students engaging in or hoping to engage in undergraduate research. Developing programs and interventions that will support URM STEM students in research settings can play an integral role in the recruitment and retention of URM STEM students.

Summary

NC State University states its commitment to students and the importance of diversity, equity, and inclusion across the board, yet opportunities continue to evade some URM STEM populations. Undergraduate research engagement continues to be a high impact practice where

URM STEM students continue to lag behind White students. Understanding the lived experiences of URM STEM students engaging in undergraduate research can aid in the design and implementation of an intervention that can aid URM STEM students in navigating the undergraduate research experience and hopefully yield a positive experience that will open the doors to graduate education and becoming research leaders in STEM disciplines.

While the definition of underrepresented student goes beyond the racial factor, race still tends to be the dominant characteristic as it relates to underrepresentation. One cannot think about diversity without thinking about race. Race still matters and students need opportunities to learn about and experience diversity in college if higher education is to advance the social progress of diverse communities and produce diverse leaders for the state, nation, and world (Hurtado & Alvarado, 2015). Understanding more about how talented racial/ethnic minorities experience "becoming scientists" in undergraduate science programs provides insight into the complexities of diversifying the scientific workforce (Hurtado et al., 2011).

This study will try to fully understand the lived experiences of URM STEM students and their engagement with undergraduate research at NC State University. Their narratives will be fully analyzed to bring a higher level of awareness as it relates to best practices in recruitment, identity and furthering their entry into graduate and professional programs that will undoubtedly position them to have an even greater impact on the scientific community on a global level. Chapter 2 will take a deeper look into the literature that surrounds URM STEM students in higher education. Chapter 3 will address the research methodology of the study.

CHAPTER 2: REVIEW OF LITERATURE

URM students come into higher education to reap the benefits like economic well-being and self-sufficiency which are by-products of a quality education (Ma et al., 2016). Historically Black Colleges and Universities continue to produce STEM graduates in record numbers in comparison to HWIs (Boncana et al., 2021; Owens et al., 2012). HBCUs (Historically Black Colleges and Universities) continue to offer support systems to ensure the successful navigation of STEM disciplines to URM students. While the idea of transitioning to a more diverse population at HWIs is not without challenges (Hunn, 2014), there are some benefits that URM students can receive at an HWI. Cross-institutional studies show that campuses with more racially and ethnically diverse student bodies tend to have higher levels and better quality of cross-group interactions which tend, in turn, promote educational outcomes (Morrison & Grbic, 2015). HWIs benefit from the diversity impact that URM students bring to their campuses (McGee, 2021; McGee & Bentley, 2017).

URM students at HWIs are not performing undergraduate research at the rate of well represented students. There are barriers that prohibit the pursuance of these opportunities for URM students. Unconscious bias, microaggressions, stereotype threat, social isolation, code switching, and imposter syndrome are some of the barriers that URM students face in the research settings at HWIs. The struggles to engage in experiential learning opportunities like undergraduate research for URM STEM students at HWIs is a phenomenon that researchers have examined for quite some time but has anything really changed as it relates to the attitudes and barriers that seem to interfere with URM students' representation?

There is a fair amount of research that examines the experiences of URM students pursuing undergraduate research and the barriers that exist (Hurtado et al., 1998; Whittaker &

Montgomery, 2012). This study will add to that body of literature by exploring and examining the experiences of URM STEM undergraduates who are engaging in undergraduate research experience and have shown an interest in pursuing a STEM graduate program. This study explores the lived experiences of URM STEM students engaging in research at NC State University. Furthermore, an intervention intended to add benefit to the undergraduate research experience and positively affect the science identity formation of these URM STEM students will be developed, implemented, and evaluated.

Chapter 2 provides a review of the literature on the underrepresentation of URM students in STEM higher education and the importance of diversity and undergraduate research engagement. The chapter begins with the self-efficacy theoretical framework and its relationship with science identity development/self-efficacy. Following the theoretical framework section, I will further explore diversity in higher education and the history of URM STEM students in historically White spaces. I will also examine URM STEM students and undergraduate research, and the societal inequities that can present for URM students engaging in undergraduate research at HWIs.

Theoretical Framework Guiding the Study

Self-efficacy is an individual's confidence in their own ability to perform a specific behavior and to perform it well (Bandura, 1977). The presence of self-efficacy in underrepresented students is important in the research settings. Self-efficacy refers to self-evaluation of a student's ability to execute a course of action to reach a desired outcome effectively. Self-efficacy refers to an individual's belief in their capacity to execute behaviors necessary to produce specific performance outcomes (Bandura, 1977; 1986; 1997).

Self-Efficacy Theory

Science self-efficacy is a person's belief in the ability to successfully complete specific tasks in the field of science (Robnett et al., 2015). Self-efficacy beliefs are assumed to form our primary sources of information: personal performance accomplishments, vicarious experiences (e.g., observing similar others), social persuasion, and physiological and emotional states. Personal accomplishments (successes and failures with specific tasks) are assumed to offer a particularly compelling source of efficacy information, but the nature of the social models and reinforcing messages to which one is exposed, and the types of physiological states one experience while engaged in particular tasks (e.g., low levels of anxiety), can all affect one's self-efficacy regarding different performance domains (Bandura, 1981; 1987).

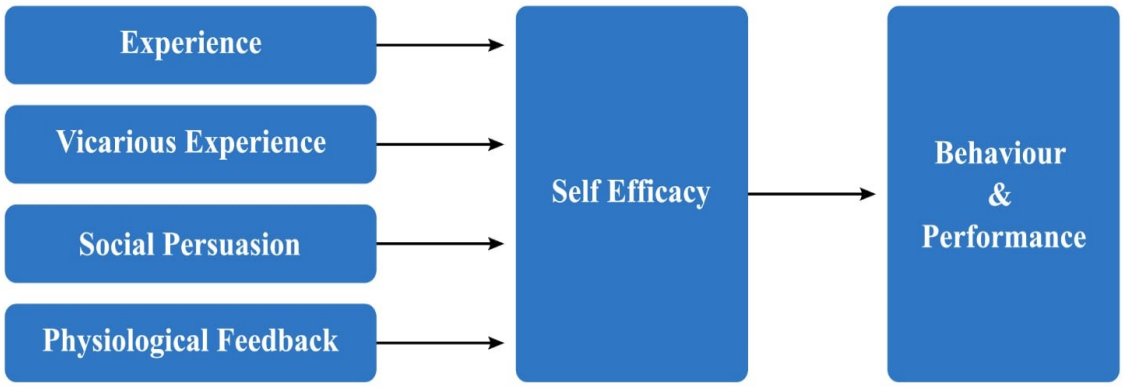
Research educators employing experiential teaching strategies may feel affirmed in learning that performance accomplishments comprise the most dependable and potent source of efficacy information (Bandura, 1981; 1986). Extrapolating further from Bandura's theory, students' beliefs about their research competencies can be expected to influence (1) the number and type of research-related activities initiated, (2) the level of effort invested in research endeavors undertaken, and (3) the persistence exhibited in their attempts to master research content, especially when difficulties are encountered (Montcalm, 1999).

Behaviorally, people's convictions concerning their own competence are expected to affect not only the types of situations they enter, but also what, if any, coping strategies they attempt (Montcalm, 1999). Bandura (1981) states, "People tend to avoid situations they believe exceed their capabilities, but they undertake and perform with assurance activities they judge themselves capable of handling" (p. 201).

Scientific self-efficacy is linked to having a scientific identity. Self-efficacy is developed through a dynamic interplay of individual perceptions and behaviors and the external environment (Bandura, 1997; Hurtado et al., 2008). Zajacova et al. (2005) suggest self-efficacy is a cognitive factor that significantly affects academic retention and performance among college students, especially in underrepresented students in science, technology, engineering, and mathematical fields.

> Bandura (1997) explains that when a devalued group becomes the target of blame for negative characteristics that others associate with them, group members may eventually believe those degrading qualities about themselves. The influences of environmental structures are significant, but they are only part of the equation, as Bandura also rejects a socially deterministic view of self-efficacy. He instead gives equal attention to the possibility that people within socially disadvantaged circumstances can overcome said obstacles if their perceptions of individual efficacy and behaviors are able to compensate for negative external ascriptions (Hurtado et al., 2008)

Academic self-efficacy refers to students' confidence in their ability to conduct such academic tasks as preparing for exams and writing term papers (Zajacova et al., 2005). Bandura (1993) posits that self-efficacy beliefs affect college outcomes by increasing students' motivation and persistence to master challenging academic tasks and by fostering the efficient use of acquired knowledge and skills. Self-efficacy plays a key role in underrepresented students being successful in the academic setting (Torres & Solberg, 2001). Figure 1 provides a visual representation of the self-efficacy model.



Note. (Bandura, 1977).

Figure 1. Bandura's Self-Efficacy Expectancy Model.

Science Identity/STEM Identity

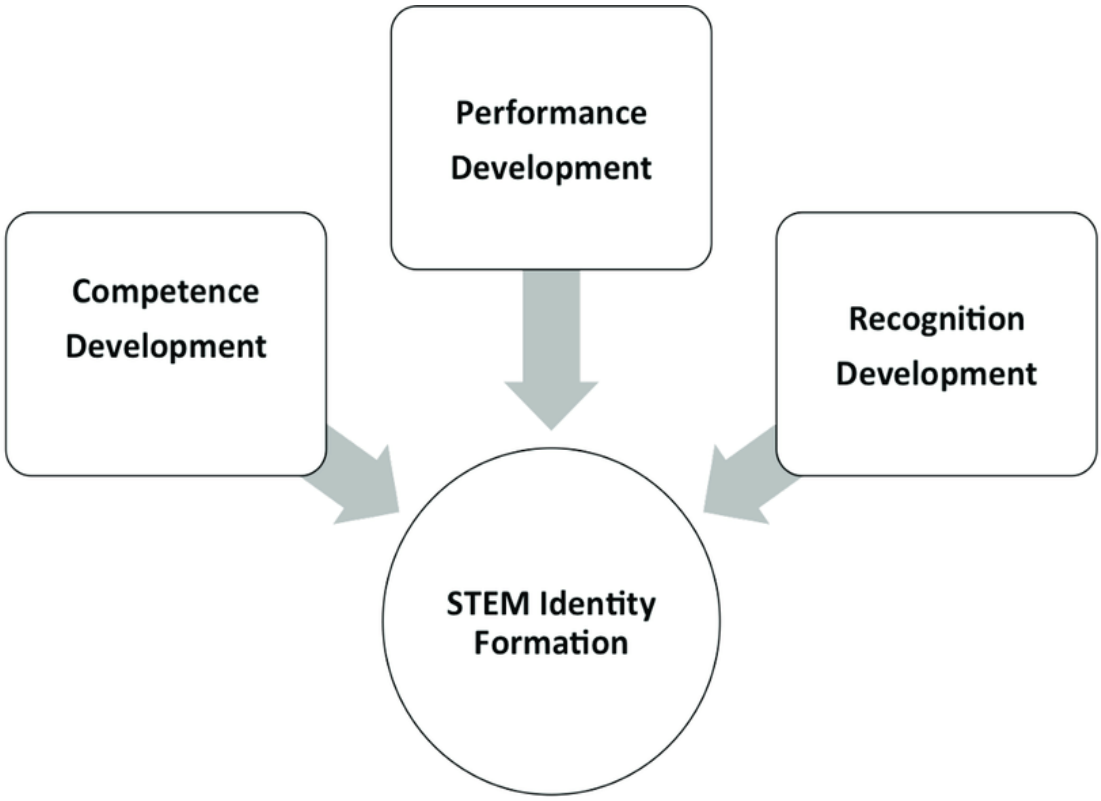
Carlone and Johnson (2007) developed a grounded model of science identity using research on successful women of color in science. Science identity theory supports a significant role for mentors in helping mentees to develop scientific knowledge competence, to learn to practice science, and in recognizing mentees as scientists (Carlone & Johnson, 2007; Prunuske et al., 2013). Carlone and Johnson's science identity model is formulated on the explicit assumption that an individual's gender, racial, and ethnic identities influence one's science identity (Hurtado et al., 2008). Participating in undergraduate science research opportunities through structured programs appears to contribute to persistence and the development of an identity as a scientific researcher (Hurtado et al., 2010; Hurtado et al., 2011).

Fostering science identity development involves more than focusing on individual factors such as increasing one's level of competence in science. Science identity involves social factors, including socialization into the sciences and making meaning of science-related experiences, such that an individual not only feels like a science person, but also acts and is seen by relevant others as a science person (Hurtado et al., 2008; Hurtado et al., 2011).

URM STEM Students and Science Identity Development

STEM identity, or particularly a science identity, is a type of social identity, one in which individuals view themselves in terms of their membership in the scientific social group (Kim et al., 2018; Nealy et al., 2019). Science identity is the extent to which a student self-identifies with the attributes, traits, and qualities that are associated with what it means to be a scientist (Osueguera et al., 2019). Science identity is who students are, what they can do, and what they aspire to do and become as it relates to science (Brickhouse, 2001; White et al., 2018). Malone and Barabino (2009) indicate that a science identity requires a sense that one is believed worthy

of participation in the science community. Competence development, performance development, and recognition development are the dimensions that come together to form science/STEM identity (see Figure 2).



Note. (Adapted from Caroline & Johnson, 2007, p. 1,191).

Figure 2. The dimensions of STEM identity development.

URM STEM students' backgrounds and heritages inescapably influence their science identity development (Nealy et al., 2019). Developing a strong STEM identity can be significant for URM STEM students' experience as they navigate the undergraduate research space. URM STEM students who feel validated can often find success as they engage in undergraduate research. A strong science identity has appeared as a key theme for improving the retention and academic success of all STEM students but is especially pronounced for URM STEM students (Suleman, 2020; U.S. Department of Health and Human Services, n.d.c.).

Science identity has recently begun to move to the forefront of science education research (Brickhouse & Potter, 2001; Brickhouse et al., 2000; Brickhouse, 2001; Carlone & Johnson, 2007; White et al., 2018). Researchers have highlighted several college experiences and contexts that influence science identity development (Betz et al., 2021). Hurtado et al. (2009) found that undergraduate research experiences enhance student interest in becoming a scientist, as students improved their knowledge and understanding of science (Sabatini, 1997) and developed their professional confidence (Betz et al., 2021; Lapatto, 2003; Mabrouk & Peters, 2000).

Science identity requires individuals to learn, talk, and represent science (Aikenhead & Jegede, 1999; Elmesky & Seiler, 2007; White et al., 2019). Research has shown that postsecondary students who are planning to have STEM careers tend to have low self-perceptions of themselves (Hazari et al., 2013; Nealy et al., 2019). Understanding how URM STEM students identify and how their various identities interact with their science identity is important in understanding how URM students engage in science learning and how they view themselves and whether they see themselves as the type of person who does science (Brickhouse et al., 2000; White et al., 2019).

Previous research has shown that race can also be a factor in developing a strong science identity. African American students majoring in science fields must negotiate both their racial and science identities as they navigate different science communities of practice (White et al., 2019). Having a strong science identity can certainly help URM students navigate the undergraduate research environment. Research has shown that reinforcing URM STEM students' science identities aids in their retention in STEM (Estrada et al., 2016; Nealy et al., 2019; Snyder et al., 2016).

URM STEM students' science identity is based on their perceptions of themselves and how they perceive others view them as they engage in undergraduate research and other science related activities (Aschbacher et al., 2010; White et al., 2018). A critical component to URM STEM students' STEM identity development and socialization into the sciences involves being seen by relevant others as a science person (Carlone & Johnson, 2007). Research experience in the undergraduate years can be a means to encourage students to think of themselves as scientists and to aid students in solidifying career plans in the sciences (Slovacek et al., 2011). Hurtado et al. (2016) indicated that research was found to be a positive predictor of a sense of belonging among URM students in the biomedical and behavioral sciences. One strategy for fostering scientific identity and increasing its salience among STEM undergraduates is mentoring (Atkins et al., 2020). Particularly among URM students in STEM, mentoring has been shown to foster scientific identity and STEM career paths (Atkins et al., 2020; Summers & Hrabowski, 2006).

Diversity Impact on URM STEM Students

Diversity and the URM Student in Higher Education

Diversity is still an important imperative for the United States, its cities, and its communities, and it is one in which higher education has a significant role (Briggs, 2017; Jones

et al., 2018; Smith & Schonfeld, 2000). Having diversity across discipline boundaries is important. For most students, higher education is uniquely situated within late adolescence and early adulthood, when individuals shift from an unwavering endorsement of the worldviews of their parents, guardians, and teachers and begin to explore where they see themselves fitting into society and political discourse (Sorensen et al., 2009). Diversity efforts in higher education focus on increasing representation of URM students and understanding sociocultural differences (Goodman et al., 2014). There has been much research into diversity and its impact on students – research that addresses this need by moving the discussion about the benefits of diversity beyond intuitive conclusions to include quantitatively and qualitatively based findings (Smith & Schonfeld, 2000). Gurin et al. (2002) argue that new experiences with diversity, particularly diverse viewpoints, tend to foster more active thinking and decision-making that is informed by a more complex multifaceted worldview rather than passive commitments based on prior experiences.

A lack of diversity hinders the advancement of knowledge across the board. It is certainly critical in STEM fields. Lack of diversity is a troubling phenomenon and will continue to impact society. Increasing the number of URM students completing advanced scientific degrees that lead to scientific research careers is critical to national interests (Hurtado et al., 2008). There are significant health disparities in this county, and we need a diverse and innovative research community to help identify and address these problems (Hurtado et al., 2008; Prunuske et al., 2013). The participation of a broader range of students from diverse backgrounds has been found to positively contribute to disadvantaged students' social mobility and economic potential in STEM and enriches STEM fields by contributing alternative perspectives (Collier & Blanchard, 2023; U.S. Department of Health and Human Services, n.d.a.).

A growing body of research focused on the benefits of diversity shows that teams composed of people from a variety of backgrounds and experiences produce better and more innovative products and ideas than that of a homogeneous team (Hale, 2023; Harris & Lee, 2019; Hurtado & Alvarez, 2012; Kardash, 2000; Vos et al., 2016). URM students enter higher education and express an ardent desire to contribute to the field of science and find cures to persistent health problems that plague underrepresented groups (Hurtado et al., 2010). While underrepresentation in research amongst URM students is known, all the reasons that impede underrepresented students from undergraduate research at HWIs are unknown.

In the book, Defending Diversity Affirmative Action at the University of Michigan, Gurin et al. (2004) states, "The social learning that can follow from a diverse student body goes even further than promoting cognitive challenges and stellar performances. We must help construct environments for intergroup relations that pave the way for racial integration – for living and working harmoniously together across the lines of race in America. This is an endeavor that takes demanding work, including a willingness not to paper over discomfort, mistrust, fear, or even conflict. There is bound to be a wariness on all sides that comes from the absence of experience with integration and from concerns about social identity."

Colleges and universities that diversify their student bodies institute policies that foster genuine interaction across race and ethnicity providing the first opportunity for many students to learn from peers with distinct cultures, values, and experiences (Gurin et al., 2002). Institutions with greater demographic diversity in their student bodies have two important qualities: (1) the likelihood that students who are from diverse backgrounds will interact with each other increases and (2) the opinions and viewpoints of students (intellectual diversity) are more variable in such institutions (Sorenson et al., 2009).

History of URM Students at HWIs

Underrepresented students face persistent challenges in racist campus climates (Nora & Cabera, 1996). URM students face many social and academic challenges when they enter college (Engle & Tinto, 2008; Gildehaus et al., 2019; Hurtado & Guillermo-Wann, 2013; Wright, 1991). Campus racial climate models indicate an interrelationship between racial/ethnic composition of the campus, perceptions of the campus as hostile or welcoming, and cross-racial interaction on campus that influence educational outcomes (Hurtado & Alvarado, 2015).

The experiences of scholars of color at historically White institutions (HWIs) and biases toward them has been well documented in the literature (Sue et al., 2007), including the lack of mentoring. Previous research points to the negative effects that a hostile racial climate can have for URM students. Research has established that experiences of discrimination negatively affect sense of belonging and retention, even among the most high-achieving Black and Latinx students (Hurtado & Alvarado, 2015). Research indicates that URM students at HWIs experience college differently from their well represented peers and URM students are not engaged in experiential learning experiences like undergraduate research even though they have an interest in these experiences (Betz et al., 2021; Bruthers et al., 2021; Lopez et al., 2021).

Research has found that bias is a part of the underrepresented individual experience in higher education and the workplace (Dovidio et al., 2002; Hurtado & Alvarez, 2012; Kameny et al., 2014; Yadav et al., 2020). A considerable number of URM students at HWIS are matriculating in a challenging environment and experience challenges of transition and persistence (Burton et al., 2021; Gibau et al., 2010; Malone & Barabino, 2009; Whitaker & Montgomery, 2012).

Race still matters, and students need opportunities to learn about and experience diversity on HWI campuses if post-secondary education is to further advance the social progress of diverse communities and produce diverse STEM leaders in academia, government, and industry (Hurtado & Alvarado, 2015).

URM Students Gap in STEM

URM STEM students continue to enter higher education and attend HWIs in record numbers. Of the 15.4 million undergraduate students enrolled in fall 2021, 7.8 million were White; 3.3 million were Hispanic; 1.9 million were Black; 1.1 million were Asian; 663,100 were of two or more races; 107,000 were American Indian/Alaska Native; and 41,000 were Pacific Islander (National Center for Educational Statistics, 2022). While statistics show that URM students are entering higher education in record numbers, racial/ethnic minority students are still severely underrepresented in many STEM disciplines (National Science Board, 2018). Hispanic, Black, and American Indian or Alaskan Native persons collectively accounted for 37% of the US population ages 18-34 years in 2021 and 26% of Science and Education (S&E) bachelor's, 24% of S&E master's, and 16% of S&E doctoral degrees earned by US citizens and permanent residents in 2020 (National Center for Science and Engineering Statistics, 2023).

Obtaining a STEM (Science, Technology, Engineering, and Mathematics) college degree and transitioning to a STEM graduate program or entering a professional STEM career continues to pose a struggle for underrepresented minority (URM) students in general and at historically White institutions (HWIs) in particular (Whittaker & Montgomery, 2012). In 2018, among US (United States) citizens and permanent residents, Whites earned 57.9% of bachelor's degrees in science and engineering (S&E) fields and Asians earned 10.7%. Hispanic and Latinx graduates were awarded 15.1% of S&E bachelor's degrees; Black or African Americans, 8.5%; and

American Indian or Alaska Natives, 0.4%. All three groups of URM students earned a large share of bachelor's degrees in science fields than in engineering fields in 2018 (NSF Diversity and STEM Report, 2023). As we look to diversify the STEM field it is important to understand URM STEM students and their engagement in undergraduate research and continue to develop and refine support systems that are in place to help URM STEM students and in particular students who have shown an interest in graduate education.

Sustaining interest in a scientific career is every bit as important in producing the scientific workforce as is generating the interest and knowledge in the first place (Summer & Hrabowski, 2006). Understanding more about how talented racial/ethnic minorities experience "becoming scientists" in undergraduate STEM (Science, Technology, Engineering, and Mathematics) programs provides insight into the complexities of diversifying the scientific workforce (Hurtado et al., 2008; Hurtado et al., 2009). Exploring the experiences of URM students is worth studying. The goal is to better understand URM STEM students and how they navigate the undergraduate research world in a historically White space.

Over the past three decades, research efforts and interventions have been implemented across the United States to increase the persistence of URM students in STEM (Kuchynka et al., 2020). URM students and African American students have not experienced amazing success in science and are underrepresented in science courses and science-related careers (Russell & Atwater, 2005). URM students continue to make strides in the STEM fields over the past decade, but there is still inadequate representation and there is a push to recruit and maintain more URM students in STEM (Burton & Vicente, 2020; Peteet et al., 2015). There is still significant underrepresentation in STEM fields. Hispanic/Latino/a, African American, American Indian and Pacific Islander groups are consistently underrepresented at all education levels in STEM related

fields (Burton & Vicente, 2020; Garrison, 2013; Prunuske et al., 2016; Yadav et al., 2020). As mentioned earlier in this paper the biomedical research workforce in the United States does not reflect the diversity of the overall population, which is a challenge for identifying and addressing the nation's research problems (Valantine & Collins, 2015).

URM science majors enter college with an ardent desire to be future scientists, pursue undergraduate research, and enter graduate programs (Hurtado et al., 2010). It is increasingly important for students of color to have early and ongoing opportunities to deeply engage and think about STEM concepts as sociotechnical innovators (Garcia & Scott, 2016; Yadav et al., 2020). Both the National Institute of Health (NIH) and the National Science Foundations (NSF) have invested in research projects and other initiatives that seek to address the widely publicized crisis in STEM fields (Hurtado et al., 2010; Hurtado et al., 2011; National Academy of Sciences, 2007). Structured research and support programs help students to socialize into the culture of science at an early yet important stage in their studies (Hurtado et al., 2011). Early college experiences that focus on professional skills and deliberately linking STEM-related academic work to applicable career objectives may reinforce URM STEM students' confidence in their ability to succeed in STEM careers (Herrera & Hurtado, 2011).

Most institutions can benefit from revamping their culture of science on campus to balance the rigor and support in ways that will better acquaint students with the empowering and collaborative side of scientific discovery (Hurtado et al., 2007; Hurtado et al., 2011). The assumption that URM students' involvement in undergraduate research programs and other academic opportunities is attributed to their race is problematic and manifests itself through barriers that can and will hinder their success. The highly motivated URM students who take part

in undergraduate research programs serve as prime examples of not only who can do science, but who will do science in the future (Hurtado et al., 2009).

URMs and the STEM Workforce

The National Center for Science Engineering Statistics (NCSES) 2023 report states that a diverse workforce provides the potential for innovation by leveraging diverse backgrounds, experiences, and points of view. A diverse workforce is desirable for every type of research, including basic sciences, but is particularly called for addressing health care disparities (Jeste et al., 2009). Certain minority groups including African American, Hispanic, Native American/Alaskan Native, and Pacific Islander and the female gender – are underrepresented in the STEM workforce (Pew Research, 2018). The recruitment and retention of students from groups that are currently underrepresented in STEM fields and careers can, in part, address the needs of the future workforce (Nealy et al., 2019).

The NCES (2023) reports,

> "Representation of diverse groups based on sex, race, or ethnicity, and disability status varies within the STEM workforce, and representation in STEM occupations is uneven compared to the distribution of these groups in the working age population. Women, persons with disabilities, and persons from some racial and ethnic minority groups – Hispanics or Latinos, Black or African American, and American Indian or Alaska Native – are underrepresented in the STEM workforce compared to their share of the total population. In 2021, women made up half (51%) of the total population of 18 to 74 years and about a third (35%) of those employees in STEM occupations. Although 9% of the population had one or more disabilities at that time, 3% of those who work in STEM occupations did. When combined, Hispanics, Blacks, and American Indians or Alaskan

Natives – collectively referred to as underrepresented minorities – made up 31% of the total population and 24% of STEM workers in 2021."

Departure from the STEM pipeline occurs at different points (Clark-Blickenstaff, 2005; Herrera & Hurtado, 2011). Many students from ethnic minority backgrounds are deterred from careers in research by low expectations on the part of others in the environment, a dearth of role models, and a lack of exposure to the culture of scientific research (Jeste et al., 2009). Promoting diversity in the STEM workforce continues to be both a challenge and priority. Greater ethnic diversity in scientific research is important from both moral and practical perspectives: the United States was founded on the premise of full participation in society and equal access for all, diversity benefits learning, and ethnic minority researchers not only bring unique perspectives to scientific inquiry but are also more likely to address minority health disparities and have access to minority communities (Jeste et al., 2009). A more diverse health care workforce will lead to greater diversity among medically trained health care managers, policy makers, and researchers, who in turn may increase the promotion and development of health policies and health care research priorities that would better suit the needs of the increasingly diverse U.S. population (Cohen et al., 2002; Evans et al., 2013).

Undergraduate Research Benefits

Undergraduate research is an inquiry or investigation conducted by an undergraduate student that makes an original or intellectual, or creative contribution to the discipline (Wenzel, 2003). Undergraduate research is seen as an experiential experience that equips students with the necessary skills to prepare them for graduate level research. Wenzel et al. (2013) cited the

American Chemical Society's Committee on Professional Training description of the characteristics of undergraduate research as follows:

> "Research is the development of new knowledge or understanding to advance science. Undergraduate research is conducted with a faculty advisor or mentor. The student's research project is typically based on the faculty mentor's research interests, an arrangement which allows the student to draw upon the mentor's expertise and resources and allows the faculty mentor to develop a productive research program. The mentor meets regularly with the student to make research plans, assess risks associated with the proposed research, and review results. The student is encouraged to take primary responsibility for the project and to provide substantial input into its direction."

The primary purpose of undergraduate research is to foster student learning, the emphasis might be on helping students move along a developmental trajectory in the practice of research (Beckman & Hensel, 2009). The student-mentor relationship builds student confidence, offers encouragement when necessary and provides guidance and assistance for students' future education and career development (Wenzel, 2013).

Undergraduate Research Impact on URM Students

Though undergraduate research can benefit students across disciplines (Kuh et al., 2010), engaging a diverse pool of students in research is particularly beneficial for training and retaining traditionally underrepresented students in STEM (Cole & Espinoza, 2008; Finely & McNair, 2013; Haeger & Fresquez, 2016; Hurtado et al., 2008; Jones et al., 2010). Undergraduate research programs socialize students by connecting them with faculty and advanced peers who provide undergraduates with access to professional networks and new sources of information, and broader access to institutional resources and networks improves students' capacity to

navigate educational systems (Eagan et al., 2013). Studies show that URM students that successfully navigate undergraduate research positively affects their persistence in STEM (Whitaker & Montgomery, 2012).

Despite substantial advances and extensive efforts to bridge the divide, significant gaps are still between the educational attainment of minority students and their majority peers. One concern is in the science, technology, engineering, and mathematics (STEM) fields (Capri et al., 2017). URM undergraduate students who engage in undergraduate research can struggle, disengage, and drop out prematurely due to the culture in some institutional research settings. URM trainees may be discouraged by the fast pace and lack of flexibility of traditional pathways for progression of a research career or academic tenure track (Jeste et al., 2009). URM students' participation in structured research programs, especially those geared toward minorities, present some with a dilemma: while they enjoyed the chance to become more deeply engaged in science research endeavors, they also struggled with the potential stigma of being selected for such programs because of their minority status (Hurtado et al., 2009). URM students will continue to be grossly underrepresented if institutions that serve them fail to understand what they face in. This underrepresentation will impact their entry into graduate and professional programs on a national scale. Due to this underrepresentation, professional opportunities that improve the wealth gap in this country will not be at an equitable level for underrepresented people.

Much research has been dedicated to the role undergraduate research plays in the impact on undergraduate students. Engagement in undergraduate research promotes self-confidence and self-efficacy (Gildehaus et al., 2019; Lopatto, 2008). Students who engage in undergraduate research experience a tremendous learning opportunity (O'Donnell et al., 2015; Hunter et al., 2006; Laursen et al., 2010). Undergraduate students who engage in undergraduate research tend

to be more involved on their campuses (Kinzie et al., 2008; Kuh et al., 2010; O'Donnell et al., 2015). Participating in undergraduate research has been linked to academic success, attainment, and persistence (Blanton et al., 2008; Finley & McNair, 2013; Jones et al., 2010; Kinzie et al., 2008; Kuh et al., 2010; O'Donnell et al., 2015; Russell et al., 2007; Taraban, 2008). The benefit of undergraduate research like mentoring and exposure to the science plays an even greater role for underrepresented students (Finley & McNair, 2013; O'Donnell et al., 2015; Osborn & Karukstis, 2009).

There is a benefit to introducing undergraduate students to undergraduate research early on. This exposure impacts student retention and academic performance (Jones et al., 2010; O'Donnell et al., 2015). Empirical research points to the fact that students participating in undergraduate research are more likely to persist in their intentions to pursue a research career and enter graduate programs (Carpi et al., 2017; Lopatto, 2004; O'Donnell et al., 2015; Schultz et al., 2011; Villarejo et al., 2008).

Undergraduate research participation has been a precursor to students entering graduate school. The preparation and exposure that students receive while conducting undergraduate research can successfully prepare them for entry into master's level and doctoral programs. There are varying factors that affect a student's decision to engage in undergraduate research. Both the National Institutes of Health (NIH) and the National Science Foundation (NSF) have invested in research projects and other initiatives that seek to address the widely publicized "science crisis" facing our nation (Conte & Omary, 2018; Hurtado et al., 2010; Valantine et al., 2016).

Mentoring in Undergraduate Research

The word *mentor* comes from Homer's *Odyssey,* in which the character Mentor was described as a "wise and trusted counselor" (Jeste et al., 2009). Increasing inclusion of

underrepresented minority and first-generation students in mentored research experiences both increases diversity in the life sciences research community and prepares students for successful careers in these fields (Haeger & Fresquez, 2016). Strong mentorship has been linked to enhanced mentee productivity, self-efficacy, and career satisfaction; it is also an important predictor of the success of researchers in training (Pfund et al., 2016).

Mentoring is an important aspect of undergraduate research. Inadequate mentoring has been identified as a critical barrier to success in higher educational settings (Jeste et al., 2009). Hezlett and Gibson (2007) define mentoring as "an intense, dyadic relationship in which a more senior, experienced person, called a mentor, provides support and assistance to a more junior, less experienced colleague, referred to as a protégé or mentee" (p. 385). Effective mentoring is important to undergraduate students participating in research (Gildehaus et al., 2019; Thiry & Laursen, 2011). In recent years, the federal government, through programs sponsored by entities such as the National Institute of Health (NIH) and the National Science Foundation (NSF) have funded programs to support underrepresented students in the STEM fields. Many of the programs incorporate mentored undergraduate research experience, which has been shown to increase the likelihood of students enrolling in graduate school (Prunuske et al., 2013). Minority research training (MRT) programs at the bachelor and graduate levels are implemented across U.S. colleges and universities to diminish the educational achievement gap and foster a skilled and diverse pool of talent that meets public demands for STEM careers (Burton & Vicente, 2020). The opportunity to deeply engage with role models – be they professors, graduate students, or more advanced peers – allows students to identify similarities in their backgrounds, demystify the path their mentors took to their positions, and view themselves in those roles (O'Donnell et al., 2015). The mentoring support that URM students receive proves to be

beneficial to their success and persistence (Villarejo et al., 2008), limited research has been done to investigate this relationship directly (Whittaker & Montgomery, 2012).

Having a mentor to facilitate connections and provide comprehensive guidance contributes to student engagement, and it may be especially important for underrepresented students (Gildehaus et al., 2019; Prunuske et al., 2016; Wallace et al., 2000). Undergraduate mentees work with mentors to build their scientific knowledge, practice science, and be recognized as scientists. The three components are pertinent to developing undergraduate students' science identities (Carlone & Johnson, 2007) and supportive mentorship positively affects persistence, confidence, and satisfaction of trainees (Grandy, 1998; Prunuske et al., 2016).

The one size fits all mentoring model often used a HWIs is problematic for URM undergraduate students who do not see many others that look like them in the university setting (Yadav et al., 2020). Ross and Edwards (2016) indicate that "the absence of a person who shares a similar culture or one who belongs to the same subculture can produce a lack of access to information network thus causing an underrepresented undergraduate student to fail to learn research policies that may be help in functioning within the research community" (p. 462).

Barriers and Challenges for URM STEM Students

Researchers have pointed out how URM STEM students at HWIs must navigate feelings of isolation, racial stereotypes, and racial microaggressions (Dortch & Patel, 2017; Fernandez et al., 2021; Means et al., 2022; Russell & Atwater, 2005). Many URM students report frequent and ongoing experiences of stereotype threat, implicit bias, and microaggressions with classmates and professors (Lindwall, 2019; McGee & Martin, 2011). Hurtado et al. (1998) cited specific institutional parameters that affect the environment experienced by individuals in the academic

community, including structural diversity, the psychological climate, and the behaviors climate. When underrepresented students find themselves in research environments where they are one of a few, stigmatization can potentially affect students' levels of academic self-confidence and performance (Hurtado et al., 2008). Common barriers to engagement and persistence include feelings of isolation and inadequacy (Gildehaus et al., 2019; Guillory & Wolverton, 2008). Many underrepresented minority students experience discrimination and bias, but most incidents go unreported (Hurtado & Alvarado, 2015). Race is still at the forefront of interactions at HWIs and underrepresentation of Black, Latinx, and Native American students only serves to reinforce stereotyping and discrimination in college environments (Hurtado & Ruiz, 2012).

Many URM students are deterred from applying to graduate/professional programs in Science, Technology, Engineering, Math, and Medicine (STEMM) as they face additional challenges such as: economic hardships, imposter syndrome, and microaggressions (Barongan et al., 2023). Factors that keep URM STEM students from persisting with science include academic and cultural isolation, motivation, and performance vulnerability in the face of low expectations, peers who are not supportive of academic success, and discrimination, whether perceived or actual (Summers & Hrabowski, 2006).

Unconscious Bias

Unconscious bias, also known as implicit bias, refers to ways that humans unknowingly draw upon assumptions about individuals and groups to make decisions about them (Allen & Garg, 2016). Research points to the fact that we all hold some level of unconscious bias. Unconscious bias is just that, something of which we are not conscious. Psychologist Beverly Daniel Tatum (2008) explains that we absorb bias in same way we breathe in smog, involuntarily

and usually without any awareness of it. Individuals tend to favor the group in which they have membership (Fiarman, 2016; Morin, 2015).

Unconscious bias (implicit bias) that is backed by research and testing suggests that individuals from all backgrounds show unconscious preferences based on gender, race, sexual orientation, or other aspects of identity (Fiarman, 2016). Unconscious bias can have harmful consequences when we rely on assumptions or stereotypes to make connections between people and negative or positive attributes (Allen & Garg, 2016). Bias may unconsciously influence the way information about an individual is processed, leading to unintended disparities that have real consequences (Marcelin et al., 2019).

Negative beliefs about race (and other identity categories) are deeply ingrained in U.S. society through socializing influences such as media, education, religion, and families (Allen & Garg, 2016). Mitigating unconscious bias and improving inclusivity is a long-term goal requiring constant attention and repetition and a combination of general strategies that can have a positive influence across all groups of people affected by bias (Marcelin et al., 2019).

One's age, gender, gender identity, physical abilities, religion, sexual orientation, weight, and many other characteristics are subject to bias. Everyone holds unconscious beliefs about various social and identity groups. Unconscious bias is far more prevalent than conscious prejudice and often incompatible with one's conscious values. Tests of implicit bias (or unconscious bias) show that people of all backgrounds show unconscious preferences based on gender, race, sexual orientation, or other aspects of identity (Fiarman, 2016).

Unconscious bias matters because humans usually are not aware that it influences their attitudes and behaviors, and it often contradicts conscious values and positive intentions (Allen & Garg, 2016). A strategy to counter unconscious bias requires an intentional multidimensional

approach and usually operates in tandem with strategies to increase diversity, inclusion, and equity (Marcelin et al., 2019).

Microaggressions

Microaggression involves treatment or action. Microaggressions are the everyday verbal, nonverbal, and environmental slights, snubs, or insults, whether intentional or unintentional, which communicate hostile, derogatory, or negative messages to target persons based solely upon their marginalized group membership (Sue, 2010). Rollock (2012) defined microaggressions as persistent and often daily occurrences that are articulated to remind persons of color that they are "judged to be different, not trustworthy, less intelligent and inferior as compared to their White counterparts" (p. 518).

Microaggressions can be both verbal and non-verbal and although microaggressions tend to be subtle they can be pervasive and often uninvestigated (Morales, 2014; Solorzano et al., 2000). In many cases, these hidden messages may invalidate the group identity or experiential reality of target persons, demean them on a personal or group level, communicate they are lesser human beings, suggest they do not belong with the majority group, threaten, and intimidate, or relegate them to inferior status and treatment (Sue et al., 2007). Racial microaggressions are defined as "brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial lights and insults toward people of color" (Sue et al., 2007, p. 271).

While microaggressions are discussed from the perspective of race and racism, any marginalized group in our society may become targets: people of color, women, LGBTQ persons, those with disabilities, religious minorities, and so on (Sue, 2010). Within an academic and research setting, minoritized groups face microaggressions in many forms, such as being

interrupted, ignored, or questioned when they contribute to professional conversations (Rollock, 2012). Underrepresented students face racial microaggressions in most interracial encounters (Sue et al., 2007).

Recent scholarship has developed the term racial microaggressions to explain the racial stereotypes, insults, and alienation that URM students experience from well represented peers, staff, and faculty in higher education (Morales, 2014). Racial microaggressions are words and actions that stereotype or invalidate racially minoritized individuals (Collier & Blanchard, 2023). Microaggressions on the surface can appear harmless, trivial, or taken as "small slights," but research indicates that these behaviors have a powerful impact upon the psychological well-being of marginalized groups and affect the standard of living by creating inequities in health care, employment, and education (Sue, 2010).

The most detrimental forms of microaggressions are usually delivered by well-intentional individuals who are unaware that they are engaged in harmful conduct toward a socially devalued group (Sue, 2010). Few studies have examined the connection between varying social locations with a focus on race and gender microaggressions (McCabe, 2009; Morales, 2009; Smith et al., 2007; Solorzano, 1998). Examining the role of microaggression can allow research to gather a better understanding of how these subtle actions can affect URM students in the research setting.

Stereotype Threat

Stereotypes center around beliefs or opinions. Stereotype threat (Steele, 1997) describes one process through which unconscious bias might shape the demographic composition. It is theorized to be a contributing factor to longstanding racial and gender gaps in academic performance.

Every individual is potentially vulnerable to stereotype threat because every individual has at least one social identity that is targeted by negative stereotypes in some given situation (Spencer et al., 2016). Stereotype threat impacts underrepresented students in the academic and research settings. A stereotype is defined as "a generalized belief about the characteristics of a group" (Bodenhausen & Richeson, 2010, p. 345). Steele and his colleagues (Steele, 1997; Steele & Aronson, 1995) found that negative social stereotypes give rise to stereotype threat, a situation-specific fear that one will either be evaluated based on stereotypes or performs in such a manner to confirm those stereotypes. Stereotypes, or attitudes towards specific groups, do not necessarily reflect conscious thought (Devine, 1989).

Stereotype threat describes the situation in which there is a negative stereotype about a person's group, and he or she is concerned about being judged or treated negatively on the bias of this stereotype (Spencer et al., 2016). Stereotype threat is characterized as a situational threat, meaning that it has the potential to occur in any situation in which negative stereotypes about one's group membership are perceived to apply (Crocker et al., 1998; Shapiro & Neuberg, 2007; Steele, 1999; Steele et al., 2002)

Previous research points to the fact that stereotype threat has a negative impact on self-efficacy which in turn affects negatively on the student's ability to execute specific tasks (Boulton, 2016; Zajacova et al., 2005). URM students who are affected by stereotype expectations suffer negative consequences (McGee & Bentley, 2017; Spencer et al., 2022).

Code-Switching

A behavioral adjustment has been referred to as code-switching. Code-switching has its historical roots in researching Black women in STEM (Spencer et al., 2022). Black women have been seen as a population that rely on code-switching to navigate their environment. Black

women are harshly evaluated and stereotyped based on the hairstyles and clothes they wear in various social institutions, which either results in them challenging the injustices they encounter or feeling the need to code-switch (Davis, 2018; Jones & Shorter-Gooden, 2003; Opie & Phillips, 2015; Spencer et al., 2022). Code-switching involves adjusting one's style of speech, appearance, behavior, and expression in ways that will optimize the comfort of others in exchange for fair treatment, quality service, and employment opportunities (McCluney et al., 2019). URM students can feel that it is sometimes necessary and in the best interest to downplay their racial identity to fit in. URM students can feel the need to "act White." This façade can lead to URM students not being able to be their authentic self, thus leading to hostility and burnout.

Code-switching is shifting or manipulating one's behavior to appeal to a different crowd or audience. Black and Hispanic Americans – particularly younger, college-educated African Americans- feel the need to code-switch or change their behaviors around their White colleagues (Pew Research Center, 2019).

Seeking to avoid stereotypes is exhausting work and can deplete cognitive resources and hinder performance (Hall et al., 2012; McCluney et al., 2019). Code-switching could be characterized as the ability to adapt one's behavior as a response to a change in social context much like bilingual speakers switch languages in response to a change in linguistic context (Morton, 2014).

Research suggests that code-switching often occurs in spaces here negative stereotypes of Black people run counter to what are considered "appropriate" behaviors and norms for a specific environment (McCluney et al., 2019).

Code-switchers can navigate two (or more) distinct communities and reap the benefits of belonging to both (Morton, 2014). While reaping the benefits can be beneficial there are also

drawbacks when it comes to feeling the need to code-switch. There are both social and psychological repercussions that come along with code-switching (McCluney et al., 2019)

Imposter Syndrome

Imposter syndrome can be defined as a collection of feelings of inadequacy that persist despite clear success. Imposters suffer from chronic self-doubt and a sense of intellectual fraudulence that overrides any feelings of success or external proof of their competence. Imposter syndrome (IS) is a behavioral health phenomenon described as a self-doubt or intellect, skills, or accomplishments among high-achieving individuals. Imposter syndrome (also commonly termed imposter phenomenon, fraud syndrome, impostorism, and perceived fraudulence) was first described in 1978 by Suzanne Imes, PhD, and Pauline Rose Clance, PhD as an observation first among successful women and other marginalized groups (Huecker et al., 2022). Imposter syndrome is a commonly reported and experienced phenomenon that affects high-functioning, high-achieving individuals, particularly in medicine and healthcare (Huecker et al., 2022). Imposter syndrome can be described as feelings of inadequacy that can persist amongst individuals despite success that is clear. URM STEM students who experience imposter syndrome cannot internalize their success and subsequently experience pervasive feelings of self-doubt, anxiety, depression, and/or apprehension of being exposed as fraud in their work, despite verifiable and objective evidence of their successfulness (Huecker et al., 2022). While imposter syndrome is not exclusive to any specific group, it certainly manifests itself in URM students (Clance & Imes, 1978; Kumar & Jagacinski, 2006; McGregor et al., 2008; Peteet et al., 2015).

Imposter syndrome (IS) is a behavioral health phenomenon described as self-doubt of intellect, skills, or accomplishments among high-achieving individuals (Huecker et al., 2023).

Imposter syndrome also presents itself as impostor phenomenon in research and refers to an internal feeling of intellectual phoniness that is often experienced by high achievers and occurs among URM students (Clance & Imes, 1978; Ewing et al., 1996; Peteet et al., 2015). URM students who experience imposter syndrome underestimated their intellectual capacity and are fearful of being exposed (Harvey & Katz, 1985; Peteet et al., 2015). Previous research has found that participants with characteristics of imposter syndrome reported lower academic self-efficacy, negative perspectives of their academic context, and pessimistic outlooks toward advancing their education (Collier & Blanchard, 2023).

Specialized Programs and Initiatives

Undergraduate Programs for Underrepresented Minorities

The NIH has recognized the disparity as it relates to URM students and has dedicated resources to provide support to address challenges that URM students encounter. The programs provide financial support, classes that include exposure to the foundation of knowledge in their field, hands-on-research experience, and mentoring (Hurtado et al., 2011; Ilonze et al., 2022; Whitaker & Montgomery, 2012) The NIH supports undergraduate education in the biomedical and mental health-related behavioral science for URM students most directly through a number of programs offered by the National Institute of General Medical Sciences (NIGMS) and the National Institute of Mental Health (NIMH) (Valantine et al., 2016). The T34 U*STAR and T34 COR are two programs that focus on students in their third and fourth years of undergraduate studies.

Prior literature indicates that URM STEM students seem to benefit most from intervention programs that promote academic confidence, like undergraduate research programs, because their experiences within math and science courses can lead them to doubt their academic

ability in these subjects (Herra et al., 2009). Established by the National Institute of General Medical Sciences (NIGMS) and the NIH, the Maximizing Access to Research Careers (MARC) program is defined by the NIH as an undergraduate program that seeks "to develop a diverse pool of undergraduates who complete their baccalaureate degree, and transition into and complete biomedical, research-focused higher degree programs (e.g., PhD or /PhD)" (Barongan et al., 2023).

T34 Undergraduate Student Training in Academic Research Program

To help address the disparity, the NIH has created opportunities, such as the MARC program, which aims to support URMs while completing a bachelor's degree and help them transition into the STEMM pipeline (Barongan et al., 2023). The MARC program initiated an Honors Undergraduate Research Training program in 1977 to improve the preparation of an increasing number of underrepresented minority students in their junior and senior years for graduate training in the biomedical sciences (Hall et al., 2016). The program was developed to develop a strong undergraduate curriculum in the biosciences and to stimulate undergraduate interest in the biomedical sciences. The T34 program is designed for URM students who show aptitude and want a PhD in the biomedical field. The MARC U-STAR program is part of a larger effort at the National Institute of General Medical Sciences (NIGMS) to promote, support, and sustain the development of highly skilled, creative, and diverse biomedical workforce (Hall et al., 2016).

The U-STAR program utilizes the T34 Ruth L. Kirschstein National Research Service Award (NRSA) funding mechanism and is designed to assist undergraduate institutions to provide academic, research and professional development activities to eligible trainees (Hall at al., 2016). This award is specifically for a four-year institution with a URM population. The

program supports activities designed to improve the overall research training environment for MARC and pre-MARC (first-year student and sophomore) students and for science faculty development at MARC- supported institutions (Mervis, 2003).

MARC U-STAR grantee institutions are expected to design 2-year programs for the junior and senior (or final two) years in college that involve trainees in academic enhancement, research training and professional skills development (Hall et al., 2016). Institutions incorporate programmatic interventions widely recognized for promoting persistence in the science baccalaureate, including early research experiences, active learning in introductory courses, membership in learning communities, a research culture on campus and other experiences that contribute to belief I one's capabilities (Gazley et al., 2014; Graham et al., 2013; Hall et al., 2016; Hensel, 2012; Hurtado et al., 2009; Kuh, 2006; Miller et al., 2005). Institutions that host MARC programs develop and implement approaches to STEMM training and provide mentoring opportunities to prevent URM students from dropping out of the STEMM pipeline (Barongan et al., 2023).

T34 Program at NC State University

The T34 program was successfully rolled out at NC State University after a collaboration between the Comparative Medicine Institute and the University Honors Program. The MARC U-STAR program encourages appointment of honors students who have high grade point averages or other achievements as designated by their institutions (Hall et al., 2016). The grant was awarded by the NIH and has allowed for five cohorts. The university has submitted a proposal to renew the grant and will know the status of the resubmission in the late fall of 2023. The T34 grant at NC State University offers research support to qualifying URM students who want to major in biomedical research disciplines with training in team science. The T34 program at NC

State university emphasizes interdisciplinary research training and provides extensive hands-on experience in challenging research projects along with extensive professional development designed to prepare trainees for a successful transition to PhD in biomedical sciences or /PhD programs.

The URM STEM students who take part in the program agree to a two-year commitment and receive a stipend (~$13,104 per year), full NC State in-state tuition and fees (the provost office provides the financial backing to support out-of-state tuition for out-of-state students), additional funds to support summer research (~$3,000). The students that are selected as T34 Scholars are required to be in the University Honors Program if they are not already and must also complete the Teamwork in Interdisciplinary Biomedical Research (TIBR) Minor that was created by the partnership because of the grant funding.

The TIBR minor is a 16-hour minor designed for students who seek to gain a greater knowledge of and understanding of interdisciplinary team science. The coursework is grounded in research, leadership, communication, and application. Students participate in leadership and communication courses, team research, and application through extension and engagement.

Summary

The literature review has built a foundation to explore and gain a conceptual understanding of the intersection of cultural competence, intercultural conflict management style, science self-efficacy and the lived experiences through narratives of underrepresented minority students (URM) STEM students engaging in undergraduate research at historically White institutions (HWIs). By employing a cultural competency model for equity and inclusion, seeking to understand URM STEM students cultural conflict management style, along with their

science identity formation this research is intended to build a distinct perspective of the factors that affect URM STEM undergraduate students engaging in research at an HWI.

URM students continue to lag well-represented students at HWIs when it comes to STEM research, degree attainment, and entering graduate programs in the STEM field. Although there have been programs that have been well funded and put into place over the past couple of decades, URM students continue to fall behind well represented students.

The literature review's intent was to develop a better understanding of the historical representation of URM students pursuing STEM research at HWIs and the impact of the research culture and research mentor. The literature review indicates that we are making strides in some areas, but the same narratives continue to persist for URM students. Gaining a better understanding of the role of the graduate research mentor and their cultural competency and the impact that these individuals have on URM students' cultural competency, science identity and self-efficacy could potentially bring higher education professionals who work with these programs to a higher level of understanding and support.

CHAPTER 3: METHODOLOGY

The purpose of this qualitative study was to conduct research to further understand the lived experiences of URM STEM students engaging in undergraduate research at NC State University. The information gathered through this research study was used to develop and implement interventions intended to increase the level of support provided to these students and to help them build upon their self-efficacy and science identity formation, as well as further position them to enter graduate school. This study sought not only to understand the experiences of URM STEM students engaged in undergraduate research but also to enhance their overall research experience.

This chapter describes the research design used to address the three research questions guiding the study. Chapter 3 includes a description of the study's participants and provides details of the data collection and analysis. The chapter concludes with a discussion of the assumptions and limitations of the study.

FoP Guiding Questions

The research questions guiding this inquiry are:

- RQ1. What are the lived experiences of underrepresented minority (URM) STEM students engaging in undergraduate research at NC State University, and how do these lived experiences play out in academics, graduate school aspirations, and career choice behaviors?
- RQ2. What are the barriers and challenges to achievement for URM STEM students engaging in undergraduate research, and what can be done to address these barriers and challenges?

- RQ3. What programmatic efforts can be identified and implemented to mitigate the challenges and support underrepresented minority (URM) students engaging in undergraduate research?

The first research question sought to better understand what is happening in the research setting with URM STEM students engaging in undergraduate research at NC State University. This research question is designed to capture the widest possible range of student experiences without having my preconceived notions and assumptions guide the discussion. As the researcher, I came in with previous knowledge as it relates to URM STEM students' undergraduate research experiences. I have worked very closely with URM STEM students engaged in undergraduate research through an NIH grant-funded program (T34).

The second research question sought an understanding of the challenges and barriers that may be present in the research setting and the support mechanisms that URM STEM students feel are lacking. This research question guided the development and implementation of interventions that were designed to help URM STEM students effectively navigate the research space, fully capitalize on the benefits of undergraduate research, build upon their science self-efficacy, and see how the undergraduate research experience can better position them into entry into graduate school.

The third research question was intended to identify and implement interventions to better support URM STEM students engaging in undergraduate research. The question will help me to better understand what interventions can potentially work to support URM STEM students in their research endeavors. Understanding the effectiveness of the interventions will equip me and other stakeholders working with URM STEM students engaging in undergraduate research in historically White spaces with the tools that are imperative in helping URM STEM students

successfully navigate and fully maximize undergraduate research opportunities. This research looked closely at the everyday lived experiences of URM STEM students engaging in research at NC State University with the hope of gaining clarity as to what it is like for URM STEM students to navigate the research space.

Inquiry Design and Rationale

This qualitative research study explores and examines the lived experiences of URM STEM students engaging in undergraduate research in a historically White space. A series of open-ended questions were asked of the study's participants to better understand their research experiences. This process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data (Creswell & Creswell, 2018).

The qualitative approach was narrative inquiry. Narrative inquiry is a qualitative method that explores the experiences of a targeted population. As a qualitative methodology, narrative inquiry is proper for exploring the experiences of a population that has thus far been understudied, whose voices are lacking in previous research, and who need to be empowered to share their stories (Creswell, 2013). The use of in-depth interviews allowed me to gather detailed information about the everyday lived experiences of URM STEM undergraduate researchers. Narrative research involves collecting stories from individuals about their lived experiences that are simultaneously unique and universal (Denzin & Lincoln, 2000; Kim, 2016).

Research Question 1

To further examine and understand the lived experiences of URM STEM students engaging in undergraduate research at NC State University, I asked a limited number of open-

ended questions to invite participants to reflect on their experiences in undergraduate research. I was interested in the mentoring aspects of the undergraduate research experience and how URM STEM students interact with research mentors. I completed a series of one-on-one interviews to collect this data. I came into the research with years of experience in working with URM STEM students engaged in undergraduate research. This research allowed me to engage with URM STEM students on a different level as researcher. This approach allowed me to gain a better understanding of the undergraduate research culture as it relates to URM STEM students engaging in research in a historically White space.

This research question examined the undergraduate research experience's impact on other aspects of URM STEM students' higher education experience, including academics, graduate school knowledge and goals, and career aspirations. I sought to better understand the impact of engaging in research for URM STEM students. This question helped me to better understand URM STEM students' engagement and interactions in undergraduate research and how self-efficacy and science/STEM identity formation is actualized for participants. I wanted to understand if URM STEM students' confidence is elevated because of their undergraduate research experience. As previously mentioned, I wanted to approach this question in the most generic sense to not affect the narratives of the URM STEM students taking part in the research. This question allowed URM STEM students to articulate their experiences and make connections to their overall student experience.

Research Question 2

To better understand the barriers that URM STEM students face in the undergraduate research setting, I asked open-ended questions that allowed URM STEM students to reflect on their undergraduate research experiences and specifically speak about the challenges they face.

In doing so, I asked URM STEM students what they need to potentially eliminate or help them overcome challenges in the undergraduate research setting. I wanted to hear directly from URM STEM students as it relates to support systems that they feel could be most beneficial. To further explore this research question and develop an impactful intervention to support URM STEM students engaging in research, I talked with inquiry partners and solicited their feedback as to what could potentially be instituted from a programmatic standpoint to support URM STEM students in their undergraduate research engagement and achievement. This was done by discussing some recurring themes that surfaced from analyzing the data from the in-depth interviews and tapping into their institutional knowledge gained from working with URM STEM students engaging in undergraduate research. I was interested in having conversations with inquiry partners pertaining to their observations of URM STEM students, their experiences, as well as best practices for engaging and supporting URM STEM students in historically White settings engaging in undergraduate research. I wanted to know some of the stories they hear from URM STEM students about the undergraduate research culture. I used inquiry partners to develop and implement the interventions. I reviewed previous research related to programmatic interventions that have been utilized. I conducted a review of these interventions and examined how the interventions were assessed.

Research Question 3

Understanding and being able to develop, implement, and explore an intervention was a significant part of this research study. This was facilitated through the third research question. Understanding what URM STEM students need and what areas of support they find to be most beneficial can be critical in support programs. Support programs have included financial support, facilitating scientific curiosity, academic support, and mentoring. Mentoring appears in the

literature as a significant aspect of undergraduate research. From my professional engagement, mentoring has surfaced repeatedly as an area that impacts the overall experience. This research question helped me to understand what interventions are effective and what more can be done to support the undergraduate research experience, science/STEM identity formation, and graduate school endeavors.

Context of the Study

NC State University has $546 million in annual research expenditures. NC State University is No. 6 in research spending among public universities without a medical school. The university has a $1.95 billion endowment, among the top ninety largest higher-education endowments in the country and has a $1.84 billion budget for fiscal year 2022.

The population for this study was drawn from North Carolina State University. NC State University has a current enrollment of 37,873. Of that number, 25,312 are seeking bachelor's degrees; 5,899 masters; 3,667 doctoral; 339 Doctor of Veterinary Medicine (DVM). A further enrollment breakdown is as follows: Agricultural Institute (211), Undergrad non-degree studies (1,619), undergraduate certificate (175), graduate non-degree studies (346) and graduate certificate (245) make up the other categories. Of the over 37,873, 49% are female and 51% are male with 79% being in-state and 21% being out-of-state.

The undergraduate race/ethnicity makeup for fall 2021: (Total enrollment – 36,831) American Indian – 0%; Asian – 8%; Black or African American – 6%; Hispanic/Latino - 7%; Native Hawaiian or other – 0%; White – 67% Two or more races – 4%; Race/ethnicity unknown – 3%; Non-resident alien – 3%.

According to the NC State University's website, diversity is especially important. The university commitment to diversity statement listed on their website reads, "Diverse experiences

and perspectives enrich our lives. They give students the insights needed to succeed in today's global marketplace, and they make us more conscientious global citizens. We expect everyone in the wider Wolfpack to champion this work and to give of their time, effort, and talent to support it." NC State University commitment to diversity statement supports the fact that the university should be committed to making sure the playing field for URM STEM undergraduate students is equal and that their research engagement should be occurring in a fair and supportive manner. Based on the statistics of URM STEM students engaging in undergraduate research there is something that is preventing URM STEM undergraduate students from performing research at the rate of well represented students on a national scale. Furthermore, as an administrator who has engaged closely with URM STEM students, I can attest to the fact that many URM STEM students struggle in the research environment. Some URM STEM students are not leaving the undergraduate research experience with a higher level of science self-efficacy or an ardent desire to attend graduate or professional school in fact in some cases that exact opposite has occurred.

Collaborative Inquiry Partners

In conducting this research, the primary participants were drawn from URM STEM undergraduate students involved in biomedical research through a grant funded program that is a collaboration between the Comparative Medicine Institute, the College of Veterinary Medicine, and the University Honors Program. The NIH funds this program (T34). The NIH is an organization that has a history of understanding URM students' success in STEM. I also worked with the Office of Undergraduate Research, STEM programs, and STEM colleges to gain access to URM STEM students who are engaging in or have engaged in undergraduate research.

I used the inquiry partners over the course of the research study to discuss the questions asked during the in-depth interviews, in the development and implementation of the intervention

stage, and the analysis of the intervention stage. This research engaged the research already conducted as it relates to URM STEM students and undergraduate research. The purpose of this research study was to build upon and offer a distinct perspective related to understanding URM STEM students' engagement in undergraduate research at one historically White institution.

Ethical Considerations and Informed Consent

Ethical considerations and how this research may affect URM STEM students engaging in research in a historically White space was fully considered in all phases of this study. The ethical considerations that need to be anticipated were extensive, and they were reflected on throughout the research process (Creswell & Creswell, 2018). Leedy and Omrod (2015) addressed four categories that ethical issues fall under: protection from harm; voluntary informed participation in the research; the right to privacy; and honesty with professional colleagues. I was fully aware of these categories and was mindful of them and committed as a researcher to adhere to ethical practices in all phases of the study.

A crucial step in assuring ethical practices involved seeking Institutional Review Board (IRB) approval from East Carolina University. IRB committees exist on campuses because of federal regulations that provide protection against human rights violations (Creswell & Creswell, 2018). A letter of support from NC State University was acquired. The approval from both entities ensured that compliance regarding human subjects was happening throughout the entire research study.

It was important to protect the confidentiality of the URM STEM students taking part in the study. Their protection was a priority in all phases of the study, and this was done by using pseudonyms. When working with qualitative data, researchers disguise or remove information that might directly or indirectly lead to the identification of the participants and other people,

organizations, and places described (Heaton, 2022). The participants were told of the confidentiality exercised by me as the researcher to protect their identities. Participants were made fully aware that their participation in this research study was voluntary, and they had the right to remove themselves at any time without any sort of penalty. The IRB approval is included in the Appendix of this dissertation.

Inquiry Procedures

This qualitative research study consisted of three phases. A part of the initial phase (Phase I) involved reviewing the literature that explores and examines URM STEM students engaging in undergraduate research. The latter part of Phase I involved in-depth interviews with URM STEM students engaging in undergraduate research. I received IRB approval before I began the interview phase of the study.

In Phase II, I analyzed the data collected in Phase I and developed interventions based on the findings. Even though I had worked with URM STEM students I had no way of fully knowing what the data would reveal, but as a professional who has worked very closely with URM STEM students engaging in undergraduate research, the issue of mentoring has consistently taken center stage. As a result of maintaining an open mind regarding the findings, I did not initially determine the nature of the intervention(s) or the intended recipients. However, mentoring emerged as a potential area for consideration. The data could have indicated an intervention specifically designed for URM STEM students or one targeting their mentors.

The intervention could address the processes associated with URM STEM students engaging in undergraduate research. This could potentially lead to an intervention that addresses and improves program organization and eliminates bureaucratic red tape-type issues that can impede students' progress. Often URM STEM students must fulfill certain requirements to

engage in programs receiving grant funding. In these cases, creating some sort of onboarding intervention could eliminate the stress of meeting these requirements. The data could also point to an intervention intended for those who work with the URM STEM students like graduate-level mentors. The data uncovered drove Phase II of this research study.

Phase III involved implementing the interventions and examining the interventions for their overall effects. In this phase I wanted to find out whether and how the intervention(s) made a difference in the research life of the URM STEM students. Did the intervention have an impact on URM STEM students undergraduate research engagement and did it affect their undergraduate research achievement? I also discussed the intervention's effectiveness with the inquiry partners. I was interested in collecting their thoughts on the intervention. I was interested in finding out if the intervention's design, development, and delivery changed inquiry partners' perspective and experience in any meaningful way. As change agents at the institution, did the intervention affect the inquiry partner's philosophy, perspective, and practices throughout their engagement with the research study? I also wanted to understand how the interventions could better support the program and the program's sustainability.

Phase I

The first phase of the inquiry involved a substantial review of the literature related to URM STEM students and their engagement in undergraduate research. The review of the literature homed in on the mentoring aspect of undergraduate research. I reviewed programming interventions already in place with similar undergraduate research programs.

The concluding part of Phase I involved in-depth interviews of URM STEM students in the T34 program engaging in or having engaged in undergraduate research. This phase allowed

me to gather data as it related to the lived experiences of URM STEM students and their experiences in undergraduate research in a historically White space.

Data Collection

A purposeful sample was used to gather data for this research study. The research study participants were URM STEM T34 students engaging in undergraduate research at NC State University. The T34 program at NC State University has five cohorts to date. Each cohort has up to five students in a cohort and as few as three students. There has been a combination of male and female students in each cohort. T34 students have fallen under the URM category in several ways, including race and ethnicity and disadvantaged background (e.g., eligible for free/reduced lunch for two or more years, have/had no parents to complete a bachelor's degree, were or currently eligible for a Federal Pell grant, and/or from a rural US area).

These students have been or were fully immersed in the biomedical undergraduate research culture at NC State University. The T34 program is intended to offer a strong mentoring component and all the URM STEM T34 students who take part in this program have shown a desire to obtain a PhD or MD/PhD. Since its beginning at NC State University, twenty students have been named T34 scholars. Of the twenty students, eleven have graduated and nine were still active. Of the nine active participants, five are in their second year of the two-year commitment and four are in the first year of the two-year commitment. These students are a part of the University Honors Program at NC State University and are considered high-achieving students. High achieving students are, "those who give evidence of their ability to perform well in the mental, creative, psychological, leadership, and academic fields" (Almousa et al., 2022).

Data Analysis

Conducting in-depth interviews is a valuable tool for collecting qualitative data for a research study. The semi-structured interview guide (see Appendix C) was designed to guide the overarching research questions that guided this study. These open-ended questions were intended to elicit detailed responses. The interview questions were intended to be adaptable and allow the conversation to flow. Some of the questions approached during the in-depth interview are: (1) Tell me about yourself and how you decided to come to NC State and major in STEM. (2) Tell me about your experiences as an underrepresented minority in science/research at NC State University. (3) How did you come to engage in undergraduate research? (4) What has been your experience in the research setting?

Each interview was transcribed and analyzed. The analysis identified codes, patterns, and themes that shed light on these students' lived experiences in the undergraduate research setting. The goal was to conduct enough interviews to reach data saturation. Glaser and Strauss (1967) defined saturation in these terms: “The criterion for judging when to stop sampling the different groups pertinent to a category is the category’s *theoretical saturation. Saturation* means that no added data are being found whereby the sociologist can develop properties of the category.” Once all interviews were completed and transcribed, I conducted an analysis to find emerging themes, patterns, and trends in the data. I also engaged inquiry partners regarding the data and recurring themes, patterns, and trends.

Summary of Phase I

Phase I of this study involved a review of the literature, a reflection of my professional engagement with URM STEM students engaging in undergraduate research from an administrative perspective, inquiry partner engagement, and in-depth interviews. The in-depth interviews captured the primary data that guided this study's findings. The information gathered

from Phase I as well as the engagement with inquiry partners to discuss the findings of the analysis of the in-depth interviews was used to guide the development and implementation interventions designed to support URM STEM students and their undergraduate research experience. Research question 1 guided Phase I of the study.

Phase II

The second phase of inquiry involved developing interventions based on the findings of the in-depth interviews and my prior professional engagement with URM STEM students engaging in undergraduate research in a historically White space. I further explored the barriers and challenges that URM STEM students addressed in the interviews and consulted with the inquiry partners to develop these interventions. I engaged inquiry partners with a series of one-on-one conversations and group conversations over the course of the research to discuss the progress of the research inquiry and to gather their feedback related to the progress of the research. I consulted with inquiry partners throughout Phase II. I engaged with the inquiry partners as I continued to analyze the data from Phase I.

The intervention(s) were delivered over a summer session and fall semester. As mentioned, I allowed my prior knowledge of working with URM STEM students engaged in undergraduate research and Phase I findings to guide the intervention(s). I was fully aware that the mentoring part of undergraduate research experience seems to resurface repeatedly in the lived experiences of URM STEM students engaging in undergraduate research. Earlier research points to the importance of the mentoring aspect of undergraduate research. The intervention's purpose was to positively affect the URM STEM students' undergraduate research experience and mentoring is a suitable area to address due to its overall impact and importance. This intervention could have been an intervention directed and delivered directly to URM STEM

students or those who mentor them. The intervention could have also been more organizational. Again, the findings in Phase I guided Phase II and after Phase III of the research study.

Inquiry Approach/Intervention

Based on the literature and prior knowledge of the FoP, I delivered the intervention to the URM STEM students taking part in the T34 and other URM STEM students and well represented students engaging in undergraduate research. Based on earlier knowledge and the review of relevant literature, graduate-level mentors also participated with one of the interventions. Due to this research study's timing, the intervention was just offered over the course of one summer session and one semester.

Summary of Phase II

Phase II of this study involved engaging with my inquiry partners, using my prior knowledge of engaging with URM STEM students engaging in undergraduate research, and fully analyzing the data captured through the in-depth interviews to develop and deliver an intervention. The final details of the intervention will emerge from the data collected and were analyzed through the research study's first phase. The intervention happened over one summer session and one semester. Research question 2 guided Phase II of this study.

Phase III

The final phase of inquiry involved the implementation of the interventions to URM STEM students engaged in undergraduate research. This strategy allowed for a better understanding of the effectiveness of individual components of the intervention and to get a feel of how students engage with the interventions. Certain aspects of the intervention were utilized for the grant proposal renewal. Participants involved with the intervention had the opportunity to speak about the intervention and its overall impact and effectiveness. I involved the inquiry

partners in Phase III of this research study to talk through the intervention with them and gather their thoughts related to the development and implementation of the intervention.

Analysis of Approach

I developed a system to analyze the intervention once the intervention was designed and implemented. I reviewed similar interventions and used prior research to examine and analyze the intervention(s) that took place. To have fully elaborated on the analysis of approach as it relates to the intervention would be premature in the proposal phase of this research study as the intervention had not been developed. The intervention was not developed until after Phase I of the study. I collaborated with the inquiry partners during this phase of the study.

Summary of Phase III

In the final phase of the research study, I engaged in implementing the interventions that were developed because of the findings in Phase I of the research study. Analysis of the implementation of Phase III of the study was shared with inquiry partners. Research question 3 guided this phase of the study.

Instrumentation

There are several data gathering methods for qualitative research projects. Key among the data gathering methods are interviews, focus group discussion, observation, and document analysis (Madondo, 2021). These methods have their instruments that are used to collect data from research sites. The following can be used as instruments of qualitative projects; observation guide, focus group discussion guide, interview guide, audio/video recorders and cameras.

The interview questions (see Appendix C) developed upon researching URM STEM students in historically White spaces engaging in undergraduate research are the main instrument of this research study. The research questions are intended to have self-efficacy theory

underpinnings, but the self-efficacy theoretical framework was applied loosely to develop the interview questions as an attempt to not sway the data gathered in any direction.

Data Processing and Analysis

I used a digital recording device to record the interviews. Transcripts were generated from the recordings. I also generated handwritten notes during the interview process to include nonverbal expressions. Creswell (2013) indicates that notes taken during the interview process serve as alternate resources if there are issues with failing recording devices.

Inquiry Design Rigor

The goal of rigor in qualitative research can be described as ensuring that the research design, method, and conclusions are explicit, public, replicable, open to critique, and free of bias (Leung, 2015). Rigor, in qualitative terms, is a way to establish trust or confidence in the findings of the research study and will provide accurate representation of the population studied.

This research is designed around a FoP that is a significant part of my profession, but I was fully aware that there are factors that may surface that had not been fully considered or examined. I used common qualitative data methods of interviewing and observation to collect data. Recurring and emerging themes were identified and categorized based on findings.

Delimitations, Limitations, and Assumptions

URM STEM students will continue to attend HWIs (historically White institutions) across the nation. HWIs will continue to have undergraduate research experiences on their respective campuses. Extending this research outside of STEM majors could potentially shed some light on other disciplines and what is occurring in those research settings. HWIs work to implement diversity and inclusion programs to address issues of equity and accessibility.

This study explored the experiences of URM students at one HWI. While there is a significant population of students at the university, there is a limited number of URM STEM undergraduate students that have engaged in or engaging in undergraduate research.

As researcher, I assume URM STEM students will be forthcoming in talking about their lived experiences in the research setting. Due to the nature of their research and research relationships, it is the desire that the URM STEM undergraduate researchers can have honest and candid conversation about their research experiences.

Role of Scholarly Practitioner

The impact of positionality on research is complex, particularly when researchers occupy minoritized identities and for research topics that interrogate power relations between identity groups (Secules et al., 2021). As the product of being educated at an HWI and now having the opportunity to work with URM students who engage the academic pathways akin to the ones I traveled as a student. I was fully aware of the day-to-day microaggressions, unconscious basis, imposter syndrome that URM students can experience at HWIs.

I did not, however, have the experience of being a URM student in STEM trying to navigate the STEM research culture in an HWI. As such, I wanted to learn from these students what they are experiencing as they engage in undergraduate research. I wanted to narrow my focus to URM STEM undergraduates who show an interest in obtaining a STEM PhD and URM students that have an interest in a PhD in the Biomedical field in particular; a field that is grossly underrepresented by URMs. I wanted to know what these students experience in their research settings. I wanted to know what principal investigators, post-docs, graduate mentors, and other administrators can do to facilitate a healthy research culture. I wanted to know what can be done to help these students develop a strong science self-efficacy and science/STEM identity. Lastly, I

wanted to know how these URM STEM students can be better supported as they matriculate into graduate school, particularly PhD programs.

I hoped and expected that the findings of this study would continue to illuminate the obstacles that emerged for URM students engaging in undergraduate STEM research, the dynamics within these research settings, the development of URM STEM undergraduate researchers in relation to science identity formation and science self-efficacy, and the narratives of URM STEM undergraduate researchers from a racialized perspective.

I was the driver of this research and the one responsible for collecting and compiling the data for this Dissertation in Practice (DiP); I recognized that this research was personal not only as it relates to my history, but issues of diversity, equity, and inclusion and social justice have both personal and professional strongholds in my life. As such I engaged with my inquiry partners to ensure that narratives are well represented, and my findings are not misleading.

Summary

This study examined the lived experiences of URM STEM students conducting undergraduate research at a historically White institution. Specifically, the researcher was interested in the lived experiences of URM STEM students engaging in undergraduate research at NC State University. The research explored the racial underpinnings of the lived experiences/narratives of URM STEM undergraduate researchers. Chapter 3 provides an overview of the research methodology and design used to collect and explore the data. Chapter 4 will explore the narratives of the URM STEM study participants, speak to the design and implementation of the intervention, and discuss the findings surrounding the intervention.

CHAPTER 4: FINDINGS

The focus of this narrative inquiry was to explore and examine the lived experiences of underrepresented minority (URM) undergraduates in science, technology, engineering, and mathematics (STEM) engaged in research in a historically White space. Examining the lived experiences of URM STEM students—from their stories of attending a predominantly White institution to their interactions and engagement in undergraduate research—offers valuable insights into how URM students navigate the research environment. This information can inform the development of programs that more effectively support URM STEM students in their research journeys. Focusing on URM STEM students engaging in undergraduate research is essential to addressing issues of systematic and institutional discrimination that have permeated the United States for centuries and continue to persist today. URM STEM undergraduate researchers with different lived experiences and identities bring diverse perspectives that shape how problems are identified and approached (Holly & Comedy, 2022).

Examining and exploring the experiences of URM STEM students engaging in undergraduate research can bring diverse perspectives and approaches to solving complex problems (Hong & Page, 2004; Hunt et al., 2015; Smith-Doerr et al., 2017; Yang et al., 2022), especially problems that directly affect minoritized communities and address racial and social inequities (McGee & Bentley, 2017). Additionally, there is a lack of recent studies examining how these lived experiences unfold in the current climate and the diverse interactions URM STEM students encounter when engaging in undergraduate research within a historically White space. The following research questions served as a guide for the study:

1. What are the lived experiences of underrepresented minority (URM) STEM students engaging in undergraduate research at NC State University, and how do these lived

experiences play out in academics, graduate school aspirations, and career choice behaviors?

2. What are the barriers and challenges to achievement for URM STEM students engaging in undergraduate research, and what can be done to address these barriers and challenges?
3. What programmatic efforts can be identified and implemented to mitigate the challenges and support underrepresented minority (URM) students engaging in undergraduate research?

Narrative inquiry (through one-on-one interviews) served as the methodological basis for this study's structure focusing on the oral narratives of URM STEM students engaging in undergraduate research. Semi-structured interviews were conducted with nine URM STEM students engaged in undergraduate research at NC State University. Five of the nine students had been involved in research for two years, while the remaining four had been involved for one year.

This chapter provides an overview of each URM STEM undergraduate researcher, and a review of the themes and subthemes gleaned from the collected data of this dissertation study. Each participant’s narrative will be discussed to help conceptualize their stories and find overarching themes and subthemes uncovered from examining the stories of all participants. Upon exploring the URM STEM students' narratives, an examination of each theme and subtheme will be presented with supporting data from the participants’ interviews.

Participant Demographics

Participants in this study are URM students at a historically White institution engaging in STEM undergraduate research. All participants are students who are T34 trainees. The T34

program is a grant-funded National Institutes of Health (NIH) program that offers undergraduate training in biomedical research (NIH, 2024). The NIH T34 Undergraduate Research Training Program is an initiative established to increase diversity in biomedical and behavioral sciences by supporting the training of URM STEM students in undergraduate research. The program provides funding to institutions to create structured research training programs for URM students in STEM, particularly those interested in pursuing advanced degrees and careers in health-related biomedical research.

The T34 program includes a summer research experience (SRE) typically eight weeks long, and trainees receive a monthly stipend and other incentives. Undergraduates are also required to engage in at least ten hours of research during the fall and spring semesters. The additional incentives of the T34 program typically include:

1. **Research Opportunities**: Students participate in hands-on, mentored research experiences, often working in a lab setting under the guidance of experienced researchers. This experience allows students to develop technical and analytical skills essential for graduate-level research.
2. **Academic and Professional Development**: The program often provides workshops, seminars, and training in areas such as scientific writing, presentation skills, and career planning, equipping students with skills beyond the lab.
3. **Mentorship and Networking**: Participants receive guidance from faculty mentors who help them navigate their academic and research paths. Programs may also connect students with a network of researchers and peers, offering a supportive community.

4. **Financial Support**: T34 grants typically provide stipends, covering research-related expenses and, in some cases, partial tuition support. This funding reduces financial barriers, allowing students to focus on their studies and research.
5. **Preparation for Advanced Degrees**: Through structured support and mentorship, the program aims to prepare URM students for graduate programs (e.g., PhD, MD/PhD) in biomedical or behavioral sciences, fostering a pipeline of diverse future researchers. (NIH, 2024)

Since being awarded the training grant, the NC State program has had a total of twenty students and all students who completed the two-year training obligation graduated from NC State University. The selection of the participants was deliberate, as the group consists of students I support in my role as the T34 Undergraduate Program Manager.

Purposive sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources (Patton, 2014). The research technique involves finding and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest (Creswell & Plano Clark, 2011). In addition to overall experience and knowledge, the availability and willingness to participate, along with the ability to communicate experiences and opinions in a reflective, expressive, and articulate manner, are essential for obtaining quality data (Bernard, 2017; Spradley, 2016).

Nine URM participants were selected to take part in the study. All participants were willing to speak about their undergraduate academic and research experiences. Table 1 displays the demographic information about the racial/ethnic identity, area of research, academic classification, time engaged in undergraduate research, and underrepresented minority

classification as defined by the NIH category. The data are presented with the pseudonyms the participants selected at the start of their interviews.

All participants are juniors or seniors. Each participant has completed at least one full summer of undergraduate research (with a 40-hour-per-week commitment) and two full semesters of research (with a 10-hour-per-week commitment). Two of the participants completed a summer research externship at other institutions (Vanderbilt University and Northeastern University). The undergraduate research experience for each student is intended to be an interdisciplinary project in which students engage in research with two different labs working together on a biomedical research project.

Since the interviews have been conducted, two participants have become full time PhD students (one stayed at NC State University, and the other is at the University of Virginia – Charlottesville); one student is completing a Post-baccalaureate (Post Bac) before applying to MD/PhD, PhD, and MD programs; one student is engaging in a two-year medical/research fellowship before applying to MD/PHD programs; one student went into industry and is planning to apply to a PhD program after gaining industry experience; one student is completing their final semester of undergraduate education (graduating one semester early) and decided to leave the training program early before applying to PhD programs; one student was terminated from the program for continuously not meeting the program requirements; and two students are continuing to engage in undergraduate research through the training program (T34), and both are in the process of applying to PhD and other graduate level programs.

The racial/ethnic identity of the participants are Asian, Black/African American, Latina/Latinx, Native American, and White. The URM categories that are represented are individuals from racial and ethnic groups that have been shown by the National Science

Foundation (NSF) to be underrepresented in health-related sciences on a national basis; individuals with disabilities, who are defined as those with a physical or mental impairment that substantially limits one or more major life activities; and individuals from disadvantaged backgrounds (NIH Interest in Diversity, 2024).

Table 1: Participant Demographics

Pseudonym	Racial/Ethnic Identity	Academic Classification	Research Area	Research Engagement Time	Category
Zara Anderson	Asian	Senior	Biological Engineering	3 years	Disadvantage Background
Dmitry Black	Black	Senior	Biological Engineering	2 years	NSF UR Race
Carla Guerra	Hispanic	Senior	Biochemistry	2 years	NSF UR Race Disadvantage Background
Alex Jacqumin	Black	Junior	Applied Mathematics	1 year	NSF UR Race
Christine Johnson	Latina	Senior	Chemical Engineering	2 years	NSF UR Race
Cassidy Locklear	Native American	Junior	Animal Science	1 year	NSF UR Race
Zoe Ryan	White	Junior	Biomedical Engineering	1 year	Disadvantage Background
Stacy	Black	Junior	Chemistry	1 year	NSF UR Race
James Young	Asian	Senior	Biological Sciences	2 years	Disadvantage Background/ Individuals With Disabilities

Data Collection

I received IRB approval in January 2024 to begin the study and to engage students in the interview process; interviews did not start until March 2024. I intentionally waited until the end of the semester to allow participants more time to gain experience in their current undergraduate research setting. The targeted population consisted of all students from NC State University who were participants in the T34 undergraduate research trainee program.

All nine interviews were performed within a two-week period. Each interview took place in a private setting behind a closed door with just me and the participant present. There were no interruptions during the course of all nine interviews. Before the interview, each student received an overview of the interview process, a copy of the interview protocol, and ample time to review the protocol and ask any questions they had regarding the process. Students were then asked if they were still willing to participate. Upon receiving a "yes" response, I asked each student to sign a copy of the protocol and at that time each student recorded the pseudonym they wanted used in the research study. Participants were provided with a copy of the interview questions so that they could have a visual of the set of questions being asked. I indicated to each student that I may have additional questions to follow up on specific responses.

The nine interviews ranged from 29:25 minutes to 62:10 minutes. Due to the nature of the semi-structured interview, I was able to further question participants regarding their responses to the set questions that were outlined. This allowed for the flexibility to further examine responses that I had not initially considered. The flexibility to explore responses in greater depth and follow up on interesting points raised by the interviewee allowed me to gain richer data from the participants.

Participant Narratives

Zara Anderson's Story

Zara, a senior and an Asian female, is classified as coming from a disadvantaged background. This designation is based on her status as a woman and the fact that neither of her parents nor legal guardians having completed a bachelor's degree. Since the interview Zara graduated Summa Cum Laude with a B.S. in Biomedical Engineering and a minor in Teamwork in Interdisciplinary Biomedical Research. Zara completed a summer research externship at Northeastern University. Unlike many students in the training program, Zara never wanted to become a medical doctor. Zara is currently a PhD student in Biomedical Engineering at the University of Virginia in Charlottesville. Just like many URM undergraduates pursuing research, Zara wants to make a difference through her research:

> I want to do some kind of long-term research position as a research scientist, whether that's the NIH, or maybe some academic institution. I'm particularly hoping to focus on research and diabetes. That's something that runs in my family. And I've seen my grandparents and my parents in general suffer from a lot of the side effects of the disease. I feel like minority patients that suffer chronic diseases experience it so differently than someone who is not a minority. I feel like a lot of times research scientists or even doctors don't really see the difference in the progression of disease based on someone's race or ethnicity, or gender or any of those factors. And so, I'm hoping in the long term I can go into research that focuses on chronic diseases that disproportionately affect minority patients.

Prior to being accepted into the undergraduate research training program, Zara engaged in undergraduate research through a summer research program geared towards women and

minorities in engineering at NC State University. Zara indicated that she had an excellent undergraduate research experience: “I was lucky that I found the lab on my first try that I really loved, and that I really like my graduate student and his mentorship style, and my Principal Investigator (PI) has been great.”

Zara built solid relationships with her graduate mentor, the PI, and other students in her lab, noting: “I think the closest relationship I have is with my graduate mentor. We’ve been working together for almost three years and now we’ll be graduating together, which is really exciting.” While Zara has had many successes as an undergraduate researcher, there have been some challenges: “I think that I felt that in my sophomore year when I was just very overwhelmed by all the things that I had going on, and I took the initiative to take a step back and think about what I wanted to continue to pursue, then that was when I started to feel better about things.” Zara exemplifies the core objectives of the T34 NIH training program, particularly through her effective utilization of available resources and her direct transition into a PhD program in the biomedical sciences.

Dmitry Black’s Story

Dmitry is a senior and a Black male, who falls under the underrepresented racial/ethnic category. Since being interviewed, Dmitry graduated Summa Cum Laude (4.0) with a B.S. in Biomedical Engineering and a minor in Teamwork in Interdisciplinary Biomedical Research. Dmitry exclusively applied to MD/PhD programs and, despite his strong GPA, research experience, and MCAT score (in the top 90th percentile), was waitlisted at one institution (later denied) and denied admission to three others. Dmitry strongly desires to obtain a MD/PhD and decided to do a one-year Post Bac to gain added research experience and clinical experience. Dmitry decided for the upcoming admissions cycle he will apply to MD/PhD programs, PhD

programs, and MD programs to broaden his chances of solidifying an opportunity for his future research and professional endeavors. In terms of coming to NC State University and majoring in STEM Dmitry responded:

> I was born in Texas but grew up in Nigeria. Education was always an important thing there. There is a shortage of doctors and a shortage of people majoring in STEM. And it always appealed to me to be someone involved in that. I mean, I would go to doctor's visits, and I would look up to people who were involved in helping people improve their health. There's a thing that people say in Nigeria – "It doesn't matter how wealthy you are, if you're never healthy you cannot pursue the things that you want to do." And I think that really stuck with me. And I wanted to be someone who helps people to be able to pursue their dreams, their passions. So fast forward, I wanted to be a doctor and research scientist.

Dmitry feels his undergraduate research experience has been a rewarding opportunity. He explains: "I think that my experience has been excellent." In responding to research relationships Dmitry indicated: "I've had really great mentors, both graduate student and principal investigator, they've both been great mentors." Dmitry stated that the mentors were not only supportive in the physical research setting but helped him apply to graduate school and other research opportunities outside of NC State. Dmitry was able to take part in an externship at Vanderbilt University. Vanderbilt University was the school where he was waitlisted for the MD/PhD program despite having a successful summer experience.

When asked about the barriers and challenges in the research setting, Dmitry indicated that he has not witnessed significant barriers: "I don't think there are huge barriers, in my experience; I haven't seen any barriers." As an African American male engaging in

undergraduate STEM research Dmitry has taken full advantage of the resources that have been available to him. Dmitry is determined to be admitted into a MD/PhD program, and his research and classroom experience has fueled that determination even more.

Carla Guerra's Story

Carla, a senior and a Hispanic female born in Spain, is classified as both underrepresented in terms of racial/ethnic background and as coming from a disadvantaged background. These classifications stem from her status as a woman and the fact that neither her parents nor legal guardians having completed a bachelor's degree. Since the interview, Carla graduated Summa Cum Laude with a B.S. in Biochemistry and a minor in Teamwork in Interdisciplinary Biomedical Research. Carla began to enjoy science at an early age: "I loved science because it was a hard thing to do." In terms of deciding to come to the United States and eventually coming to NC State University:

> I was born in Spain during a time when the economy was not the strongest, we had a big economic crisis. Growing up there I was raised with the mindset that even if you are extraordinary the likelihood of you finding a job that pays well was unlikely. We have very educated people who are unemployed. So, one of things I grew up with was this pressure of it doesn't matter how hard I try, I am never going to be able to get the things in life I want.

Carla started her education in the United States as a high school exchange student, but found herself in a challenging situation that immensely changed her trajectory:

> So, when I was fifteen, my parents offered me a study abroad program. So, I came to the States. And I started with a host family that hosted me for high school. There were a lot of shitty things that happened with the host family, we're not going to go into detail

> because they weren't the best people. Okay, they became very abusive and controlling. I was then in a situation where I could not go back home. And it took me a few years to get out of this home where I had no freedom. I then became on my own and I started working and just trying to pay for my bills and everything. And then I was 21, I had saved enough money that I was going to put myself through school now. So that's how I started my schooling. It took me a while just to get to the undergraduate level.

Carla was the oldest (twenty-six years old) undergraduate student in the trainee program. Carla began to engage in undergraduate research at her previous institution in Florida. Carla defines herself as White passing. When asked about her experience as an URM student in STEM:

> In Florida, I was not a minority because everybody is Hispanic. When I attended Florida International University (FIU) there were a lot of Hispanics, and it was great. It was rare to find a White person. Oh, my God. That was great. I didn't notice and felt at ease. There was also a significant international population. I then came to North Carolina. I felt like I rarely saw a person of color. I was like everyone is so tall and so White. So, it was a bit of a shock and there was an adjustment to fit in. The more I got to know people, it became welcoming. I feel like people here were very welcoming, regardless of ethnicity. I am White, and it is a different experience.

As a self-defined White passing student, Carla indicated it is frustrating when she speaks. She explains: "It's so annoying, when they ask where your accent is from, it's almost always an instant thing."

Carla's first appointment was in a high-profile chemistry lab. Chemistry continues to be a challenging environment for female researchers and scientists: "I think that chemistry tends to be a little more antisocial, or like most people that have more antisocial behaviors." Women have

come to recognize they are excluded from the 'old boys' club that has provided access to knowledge, mentoring, and opportunity (De Welde & Laursen, 2011). Carla was one of two female trainees who had to find another research assignment due to inappropriate conduct of male mentors. When asked about her experience in the research setting:

> I think I've had a lot of different experiences in research. On a personal level it has been difficult. Mentoring can be different. Some people are better to work with than others. Some people you have more fun working with, even though you don't learn as much. I'm in a lab now and happy. The initial lab I was in at NC State I was never given independence. I had done significant undergraduate research at my previous institution. I was becoming a little shadow because of this male graduate student. He was not a great mentor. I was not allowed to do things on my own. Imagine spending almost twenty hours a week standing behind somebody else doing things. I was never introduced to anybody in the lab. No one ever said hi to me. I felt like I was going into enemy territory. It never felt welcoming. There was another girl in the lab, and she never interacted with anyone.

Carla eventually secured a research assignment where she could thrive as an undergraduate researcher. However, her experience with a male graduate mentor led to a formal conduct hearing and profoundly impacted her desire to continue pursuing research in chemistry – a discipline she had been deeply passionate about. The negative interactions not only with the male mentor but also with other male researchers in the lab environment contributed to her decision to explore alternative fields of interest. Reflecting on this period, Carla shared: "I was really demoralized, and it affected a lot of my cognitive processing. I was anxious. I was a mess." Carla continues to speak to the experience and the toll it took on her research health: "I took a hit to my

self-worth because the PI never acknowledged me as a part of his lab, and I think that was the hardest thing."

Carla transitioned to another lab and was able to develop a solid foundation with her female graduate mentor and the male PI. Carla prides herself on doing high caliber work so when she got into her new lab and began to experience problems where she was not producing the results that she had hope for as an undergraduate researcher, she began to question her place in undergraduate research and her role as researcher:

> Being in a situation where something doesn't work and not being able to figure out what is wrong was a very frustrating experience. I did get imposter syndrome. I was thinking that these people have given me a scholarship and I am just useless. I thought I was going to get kicked out.

When Carla began to receive additional support her mindset and attitude towards undergraduate research took a positive turn. She explained: "You guys lifted me because I really wasn't feeling good about myself and I just really needed the reassurance that people believed in me, and that it was a learning process, and I was going to get there."

Carla certainly had one of the most challenging undergraduate research experiences of all the trainees taking part in this research study. Carla decided to take some time away from academics and not apply to graduate school. During the week that applications were due to NC State University for the program Carla had been interested in, she met with the training program manager, the PI for the training grant, and the PI in her undergraduate research lab. Carla was convinced to at least apply to the program and the administrators offered their full support. Fast forward a few months later Carla learned that she was accepted into a PhD program and fully

funded. Carla is currently a PhD student in Molecular Biology/Immunology at NC State University

Alex Jacqumin's Story

Alex is a Black male and a junior, who is classified as belonging to an underrepresented racial or ethnic group. Since the interview, Alex has left the T34 training program in good standing. As an undergraduate researcher, Alex has received multiple awards for his undergraduate research engagement and has enjoyed undergraduate research: "Every single day I look forward to going into the lab, talking to my lab mates, getting work done, learning new things and it is all fun." When asked about coming to NC State University and majoring in STEM, Alex responded: "So being a STEM major is basically like my entire life." STEM has always been a major part of Alex's education:

> I was about seven or eight and I wanted to be a doctor. So, I just ran with that. All that goes into being a doctor comes from science. So that was a very heavy part of my life. My parents are also very involved in keeping me interested in STEM. So, I did a lot of extracurricular activities involving science and technology events. I was involved in science, technology events and extracurricular activities through high school as well.

Alex did not find NC State to be a welcoming environment at the start of his undergraduate studies: "I tried to transfer my first semester here; I didn't really find the environment here to be very welcoming to me."

Alex began to find his place at NC State University after seeking out programs that were geared toward minority students: "I'd say I get a lot of support from programs geared toward minorities here and I engage in them fully; I took the step to get involved my first semester in programs that support minority students." Alex was involved in the McNair Scholars prior to

becoming a T34 trainee. Alex also took part in a second research program as an undergraduate student. The Directed Research for Undergraduates in Mathematics and Statistics (DRUMS) is a summer Research Experience for Undergraduates (REU) program. As a DRUMS participant Alex was involved with a research group:

> My research group was ethnically diverse, which is fantastic. And the people that I worked with did not care about race at all, they didn't care about anything, any predispositions at all, we were all equal.

As a T34 program participant, Alex initially encountered miscommunication with his PI and graduate mentor. To address this, an intervention was implemented involving an in-depth discussion among Alex, the training program manager, the training grant PI, his research PI, and his graduate mentor. This conversation revisited the details of the grant, including funding, the mentoring model, communication protocols, and the chain of command. As a result, program requirements and expectations were clarified, ensuring alignment among all parties. As a result of this strategy, Alex reported having a positive experience in the biomathematics/mathematics modeling research lab. When asked about the mentoring relationships:

> With my research PI from our first research project, it took some time to build a level of respect. It was hard to feel like I was contributing anything to the group for the first month. And you know, I had a meeting with her and addressed the issue. After that she started asking me more questions within our group meetings, accommodating me more, making sure I was a bigger part of what decisions were being made. That made me feel a little bit more incorporated, increased my motivation with the lab and made sure I was doing more work. So overall, I will increase my effort and effectiveness in the group. Now, I'm the primary person in the lab. So, I steam head ideas. I make new pitches, and

> now I analyze things. The development over time has gone from me being a newbie that can't be trusted to being the primary person being trusted and making decisions within the lab.

Alex prides himself on being a confident student and undergraduate researcher who understands how to navigate the research/academic setting: "A lot of where I stand in terms of pursuing opportunities is understanding how to get told no, not everything is going to go your way and I'm not going to let it stop me from getting to where I need to get; I'm not going to let it stop me from achieving my goal."

Even with having a keen awareness of who he is as an undergraduate researcher, Alex like other undergraduate students engaging in research can experience self-doubt:

> Sometimes I read papers that are way over my head, and I talk to people that are significantly farther ahead of me. I surround myself with colleagues who are strong researchers. You'll always have doubts whenever it comes to being around people who are in a research field, especially with something like math, there's people who are way smarter than me, whenever it comes to math way more developed than me. But I know I am capable. There's no point where you should sit and bring yourself down and feel inferior, because you don't know more.

Alex took part in a REU at the University of Wisconsin – Madison during the summer prior to his senior year and is graduating a semester early. Alex continues to engage in research with the Department of Psychology and is developing a model to measure Science Identity Development, Alex's immediate plans involve a PhD in Mathematics Education or a PhD in Applied Mathematics with a research focus on mathematical biology and ecological systems modeling/mathematics education.

Christine Johnson's Story

Christine is a Latina female and a senior, who is classified as belonging to an underrepresented racial or ethnic group. Additionally, she is identified as coming from a disadvantaged background, as she is a woman and the first in her family to pursue higher education, with neither parent nor legal guardian having completed a bachelor's degree. After the interview Christine graduated Magna Cum Laude with a B.S. in Chemical Engineering and minors in Teamwork in Interdisciplinary Biomedical Research and Biotechnology. In terms of majoring in STEM Christine responded: "I took some really intensive STEM classes in high school and gravitated towards those classes, and I always knew the pharma industry really interested me."

Christine defines herself as White passing, and she feels that it has played a role regarding how she has navigated the research setting: "My mother is German, and I do come off White passing, so in that regard, it has not majorly affected me, but I do have a Hispanic last name and I'm curious if that impacts me in some way." When asked about engaging in undergraduate research Christine responded:

> Originally, I was interested in going to medical school. I knew I just didn't want to stick with a bachelor's in chemical engineering. I always wanted to further my education. I understood the medical school aspect. But I never wanted to shut off the PhD route either. And as I got more technical, chemical engineering classes, I really started to enjoy my major and wanted to explore the capabilities and possibilities there. I thought if I get into research and really enjoy it, instead of medical school, I might want to go the PhD route. And I didn't really enjoy it. I enjoyed it a lot. And I like the autonomy that

> research brings versus I think in medicine, a lot of times at least when you're starting out, you are told what to do by larger corporate organizations.

Just like other undergraduate students who have shown an aptitude in STEM, many come into universities with the desire to enter the medical field, but their mindset shifts upon being exposed to other aspects of STEM that can oftentimes happen in the research setting.

Just like Carla, Christine had to make an adjustment to her original research plan after unwanted advances from her graduate level male mentor. Even through overcoming the negative consequences associated with the unwanted advances, Christine was still able to find something positive about her undergraduate research engagement:

> I feel like it has been very overwhelmingly positive, I have gotten a bunch of opportunities to just learn new material. I've worked on two different projects quite extensively. I feel proficient. There have also been opportunities to present my research, and I have learned a lot of very cool, niche things. I think it has just been a very good learning experience.

In talking about her undergraduate research experience Christine wanted to speak to the positive aspect of her experience first. Christine had a challenging time in reporting the inappropriate conduct of her graduate level mentor who she accused of making unwanted sexual advances and stalking. Christine had learned a great deal from this male mentor and had invested time in the research and she would be an author on an upcoming publication that centered around his research and her involvement. Christine also did not want this male mentor to be removed from the program because she saw him as a brilliant researcher, and she did not want to be the one to damage his research career. Christine spoke of the situation:

> I would say that in any work environment, you're always going to come across difficult people to work with. But I would say that in the research environment as a woman where it is so male dominant; it is harder than let's say the average work environment. So, I struggled with some power dynamics there. Because not only am I a woman, I'm also young, as an undergrad. There is a very distinct difference between graduate students and undergrads. So, it's not just I'm a female, I'm also at a lower academic rank. So, both compiled, I think made me so susceptible to working in some challenging situations. But I feel like, at the end of the day, I am still grateful for that experience, because it helped me pivot into a new project, I was able to learn a lot more, and I was able to navigate a fairly difficult situation and come out okay. I think now moving forward in my career, as it progresses, I think I'm better prepared to deal with more difficult people I will work with, and men in a STEM field. I feel a lot more comfortable in explaining my boundaries and being just a little more assertive with my ideas and decisions.

When the PI got involved in Christine's situation, he made sure that she received full credit for her contribution to the research and was included as an author in the publication that she was concerned about not receiving credit.

Despite finding a new graduate level mentor, Christine spent two years researching tissue reactive anchoring in pharmaceuticals for intra-cartilage drug delivery and presented this research domestically and internationally. Christine did not go the route the T34 training grant wants students to take; she decided to not enter a PhD program but wanted to gain industry experience before applying to graduate programs. Christine stresses she wants to use this time to better understand the pharmaceutical industry before applying to PhD programs.

Cassidy Locklear's Story

Cassidy is a junior and a Native American female, classified as belonging to an underrepresented racial or ethnic group. Since the interview, Cassidy was terminated from the training program for not meeting the ten-hour research requirement and not advancing in her research. The program staff repeatedly tried to work with Cassidy and her research team, but Cassidy failed to show up for her research and consistently put her graduate level mentor in a compromising position as it related to advancing her research. Cassidy decided that academics and family came before research. This was her decision, and Cassidy continues to stand behind her decision and continues to perform well academically.

From the beginning there was some hesitation about admitting Cassidy to the training program. As previously said, the training program is intended to support and provide resources to URM students who want to enter a PhD program in the biomedical field. Cassidy presented herself as an animal science major who wanted to apply to Doctor of Veterinary Medicine (DVM) programs but had not ruled out a PhD. Animal science and proximity to family were Cassidy's primary reasons for coming to NC State University: "I grew up in Raleigh and I came to State because of the animal science program and because it was close to home."

Unlike many of the other research participants, Cassidy entered the training program with minimal prior experience and a limited understanding of the nature and expectations of undergraduate research:

> So, during freshman year, I honestly didn't know anything about undergraduate research at all. I mean, I knew about research, but like it wasn't anything crazy. Like of course, I have labs, but that's not research that's like you learning how to do kind or research but not conducting it. So, I guess, I didn't know in the beginning how in depth like research

> really is. I would get the emails about the training program, and I read through it, and I thought this could be something for the future, like it is worth a shot.

Cassidy had difficulty with her research assignment from the very start and always felt out of place. Cassidy was the only undergraduate student in her research lab:

> I literally had no clue what was going on. I mean every time I listened to them talk, it was like they were speaking in a foreign language. I had no clue about anything that they were saying. I'll just sit there and nod my head like I knew what was going on.

Cassidy experienced some key communication problems with her graduate level mentor, and there were so many miscues, but Cassidy did not seem to understand the frustration that her graduate level mentor was having with her performance when she was asked about the mentor relationship:

> She's super, super nice. I do think we have very different personalities because I'm very talkative, and outgoing. And then she's very much like, she's super nice, but she's a lot quieter. Like, a whole different personality than me. So, like, sometimes I feel like it's hard to like, just like, say stuff.

Most research labs expect undergraduates to work just like graduate students and post-doctoral students. Most labs do have good intentions as it relates to supporting undergraduate students, but labs do expect undergraduate students to be able to navigate the landscape successfully and do not expect to have to hand hold them throughout the research process. This can be even more of a challenge for both students and mentors when undergraduate researchers do not understand when and how to ask for support:

> I feel like kind of awkward asking for help because I don't want to bother them especially because I'm not in there as much so sometimes I feel like they are like, oh she is going to

come in and like make me do something for her and then she's going to leave earlier than me. I did not have those personal connections in the lab.

Cassidy struggled from the start, and there was no intervention that could help her be successful in her assigned lab as the graduate mentor, and PI became frustrated by her performance on all levels. Even though she did not have undergraduate peers in the research setting, she initially had the support of graduate mentors and research faculty, but when they came to believe she was not invested in the process they no longer were invested in her research career. Cassidy could have potentially been successful in another lab, but because she never met her work hours requirement, the program felt it was in everybody's best interest to part ways. Cassidy is on target to graduate with high academic honors (3.92 GPA) and is applying to veterinary programs. She finished her summer strong and talked with the PI before her departure, and he has agreed to support her in her desire to enter in a Doctor of Veterinary program and will be providing her with a letter of recommendation.

Zoe Ryan's Story

Zoe is a White female and a junior, who is categorized as coming from a disadvantaged background. This classification arises from her status as both a woman and a first-generation college student, as neither her parents nor her legal guardians having attained a bachelor's degree. Zoe is returning for her second year in the training grant program and has had two summers of full-time undergraduate research and has started her third semester of undergraduate research. When asked about coming to NC State University and majoring in STEM Zoe responded:

I went to a magnet school in middle and high school. And part of that was they exposed us to different possible career choices that we could make. And one of the options was

> biotechnology and biomedical engineering. And I absolutely fell in love with it at those schools. And previously I wanted to be a veterinarian. So, NC State was already on my radar. I'd already been to the campus several times. And I knew they had a pretty good biomedical engineering program here. And when I learned more about it, I liked it even more. The first time I visited, I fell in love with NC State even more.

Zoe's research lab is headed up by a female PI and from the conversations had with undergraduate researchers, this lab has really made a real effort as it relates to diversity, equity, and inclusion. Zoe is aware of the diversity in her current undergraduate research environment:

> I am in one of the more diverse labs on campus, which I'm very lucky to be in. Diversity is something I have observed in research by interacting with various labs in and around my building, listening to stories, and witnessing the diverse perspectives within the research community. I know that's not a universal thing. So that makes me more thankful to be in the environment.

Zoe's engagement with her graduate mentor, PI, and other graduate and undergraduate students has been a positive experience: "The PI and the entire lab supports each other and provides valuable feedback as it relates how one might improve." The support that Zoe has received in the research setting has bolstered her confidence:

> I would say I'm pretty confident. I know, I dealt with a bit of imposter syndrome when I first got into it, just because it was something completely new to me. But I feel like, first of all, my grad mentor called me out. She said you don't need to be doubting yourself. So that kind of helped. And then ever since then, I've just become more confident in myself as a student and researcher. And the imposter syndrome has gone away. And now I'm just happy where I am.

Zoe has had some challenges that she relates to being a female embarking in research:

> I'm shy or it may be how I was raised. But I know, part of, or the easiest way some people say, to get into a lab is just approaching a professor and talking about the research. That is just not something that comes naturally to me. Like approaching someone and asking for something from them when I don't really know them. It just feels wrong. And like I said, I don't know if that's just because I'm a woman, I don't want to take things from people without having something to give, right? Or if it's just I'm a shy person. I would say that's been the biggest barrier.

Zoe has continued to have positive experiences as an undergraduate researcher. Zoe is on track to graduate with the highest academic honor (3.9 GPA) with a B.S. in Biomedical Engineering and minors in Teamwork in Interdisciplinary Biomedical Research and Biotechnology. Zoe also embodies what the grant is intended for as she is only interested in pursuing a PhD in the biomedical field and is currently going through the application process. Zoe has presented her research at honors type and disciplinary conferences across the country.

Stacy White's Story

Stacy is a junior and a Black female, classified as belonging to an underrepresented racial or ethnic group. Stacy is returning for her second year in the training grant program and has had two summers of full-time undergraduate research and has started her third semester of undergraduate research. Stacy has had a good undergraduate research experience: "I personally had a pleasant experience, and my research team has been open to new ideas, and it hasn't been a competitive atmosphere." Stacy indicated that she grew up in a predominantly White space and that may have contributed to her comfortability in a predominantly White and male dominated space:

> I grew up in a predominantly White area, most of my friends, people in my neighborhood were all White growing up, so I've never have really had a Black community like others may have. So, I wasn't really bothered by it. It is a White male dominated field. For sure. And sometimes, there is like a little sense that since I am a woman my ideas are received differently and for them do not come across as the best ideas. But at the same time, I am an undergraduate working with a lot of graduate students. So, I don't know if it's because I am a woman, because I am Black. Or is it because I am an undergraduate and I genuinely just don't know the field well enough to decipher how things are reacting.

Stacy has enjoyed a good relationship with her graduate level mentor who is a White male: "He's very accepting and he's very open and understands what it is like for me in that space." Stacy has had positive and constructive conversation with her graduate mentor, and she stated that he really wants to understand her experience:

> I have opened up to him about things. I feel like he's very aware. He was like, I want to understand, and I don't want to make you feel any certain type of way. He has indicated that he doesn't want to give off negative vibes as a man. And he's also good about the understanding of me being a woman in this field and that being a woman in this space can be extremely difficult.

Just like some other female training undergraduate researchers, Stacy has feelings of not wasting people's time as she navigates the undergraduate research setting. Stacy believes that if she is not fully committed to pursuing research at the highest level, she will have wasted the time of both the program and mentor. This is something that she thinks about in situations where she does not

feel like she is making considerable progress, if she is late coming into the lab or must take some time away from research:

> I am mindful that my research is important for graduate students. It is part of their projects, and they take the time to make sure you are learning the techniques the right way. If it does not work out, I feel like I wasted our time. Because I don't know what I want to do, but at the end of the day I have learned a new skill, and I need to know if that will be beneficial if I do start to get into industry and things like that, I'm helping them and helping myself. So, I shouldn't feel guilty. But I think it's just like I am a people pleaser. I don't want to make anyone upset or make anyone feel disappointed regarding the research I am doing. I want others to feel happy and content about what I am doing.

Despite these feelings sometimes manifesting in the lab setting, Stacy indicated her confidence in her abilities to navigate the research setting continues to grow. Just like other students in the training program Stacy has found a way to work through issues that created negative self-beliefs. When asked to discuss her confidence in her ability to successfully navigate undergraduate research Stacy replied:

> It's gone up more. When my mentors pushed me to do things independently that helps build my confidence. Sometimes I question whether I am doing something right. So sometimes, it's kind of like that, like imposter syndrome, just feeling like you don't deserve to be there. Because always feeling like there's just someone smarter than you. So, I feel like my confidence is getting better. It sure has gotten better from this experience. I feel like I'm totally capable of going into a new position, or like a new lab and learning super quickly, and then doing my own work and my own project, which is kind of why I submitted a proposal for an externship.

Stacy continues to navigate the research space successfully, largely due to the solid relationship she built with her graduate level mentor. Stacy is on track to graduate with the highest academic honor (3.8 GPA) with a B.S. in Biochemistry and minors in Teamwork in Interdisciplinary Biomedical Research and Sociology. Stacy most recently got engaged and her immediate plan is not to enter a PhD program. Stacy embraces being a research scientist, but she also embraces the fact of being a stay-at-home mom:

> I can see myself as a research scientist. I still don't know for a fact that being a research scientist is what I want to do. I have goals and ambitions. And is that one of them? Yes. But at the same time, I could see myself being a stay-at-home mom and being content. I feel like nothing's ever set in stone for me, because I don't want to be set in stone, I don't want to have a job like my parents did. And like, work at the same office for thirty years and retire.

Stacy is applying to multiple nursing programs, and she indicates that she still has plans to pursue a PhD in the future.

James Young's Story

James is a senior and an Asian male, classified as an individual with disabilities and from a disadvantaged background, as neither his parents nor legal guardians having completed a bachelor's degree. Since the interview James graduated Summa Cum Laude with a B.S. in Biological Sciences with an Integrative Physiology and Neurobiology concentration and a minor in Teamwork in Interdisciplinary Biomedical Research. James was born in South Korea, but due to family situations (mom passed away when he was eight) his family moved to the Philippines for a few years. He came to the United States when he was sixteen years old. Upon entering high school James struggled and coming to a university was not in his plans:

> I barely spoke English. I knew English, but still not to the degree of where I am right now. STEM degree or other things were not in, like my viewpoint or like, or in the back of my mind. I'll probably be going to help my parents with the restaurant as I was doing at the time, like my parents (father and stepmom) were running a restaurant, just weekends and occasional weekdays. But I just set out to help them. Like, that was life, I would expect that after high school graduation. Sure. College, I did not have in my mind. It wasn't an option.

The counselors at James' high school recognized something in him and began to have conversations with him about attending college. He explained: "I didn't know what the application process to college was and my parents didn't know either." Time constraints and personal health challenges limited James' ability to apply widely, resulting in a successful application solely to NC State University: "I got sick from suspected autoimmune disease and I had to withdraw from AP classes, my SAT score was not great, and I reached out to the school and said I'm trying to improve my own life where I'm trying to do something because suddenly I felt that NC State became an option."

As an individual of Asian descent, James' experience as an URM STEM undergraduate researcher differs from that of other URM students. James explained that, as an Asian male, there is a pre-existing expectation for him to excel in the STEM field:

> When it comes to representation, my gender and my racial identity is considered very overrepresented in science. That's a factor. But then the invisible factor, that is quite frankly, my parents. My parents are working people. We don't have much. So, my underrepresentation is socioeconomics. So, people will look at me and say that is a healthy Asian male and you will expect seeing him in STEM fields. But when this person

> has no background in science or higher education he is propelled into a position where people expect me to be ready. Yet, I'm also being introduced to a field where I never thought I had the option of like science. That was not an option for me. I never thought of the job prospect, like science, like doctors. Now I am going into undergraduate biology and being introduced to so many different aspects. I'm trying to fit in. But there is imposter syndrome. Do I really belong here? I didn't expect to be here. I don't write well. Now I need to fit in, adjust, and almost try to become the person that you think of me. Should I confide in some people and tell them the real story of my family, health, and socioeconomic struggles?

During his first year as a trainee, James had a challenging time due to family and medical issues. While James maintained a strong academic performance, the time he spent in the laboratory was nonexistent. There were more than a few conversations with James, his graduate mentor, the lab PI, the grant PI, and the training program manager as to whether James should remain in the program. This becomes a challenging situation with a program that is designed to support students who are at a disadvantage. Terminating a trainee for an issue partially linked to their classification as an URM presents significant challenges. In James' case, there were circumstances beyond his control that contributed to his inability to meet the expectations of the training grant. The decision was made to support James and provide him with added resources (counseling center and preventive services resources) and mentoring that could potentially aid in his success. James also disclosed a family situation in which he was responsible for caring for his younger sister while his parents worked. Combined with the health issues he was experiencing; it became evident that he had little to no time to realistically engage in the ten-hour undergraduate research committee:

> I have a seven-year-old sister. My parents are working. My father is now a general manager, and my stepmother works in real estate. I occasionally have to go home and take care of my sister who is like forty minutes away. I must consider all the socioeconomic aspects. I have to consider things like that. Unlike others I couldn't fully immerse myself in research. How could I be immersed in research, given my housing, transportation, and scheduling issues? I wouldn't say my family is a burden, but it is a fact.

James faced significant challenges as an undergraduate researcher that were unrelated to his level of commitment, including physical health issues and family circumstances beyond his control. Despite the challenges James had to overcome as an undergraduate researcher, he has published and presented his research at multiple conferences across the country. During the time at NC State James volunteered at UNC Rex Hospital, was president of the Gay, Lesbian, Bisexual, and Transgender Community Alliance (GLBTCA) and was a finalist in the NC State University Leader of the Pack competition. Although James remains committed to pursuing an MD/PhD, he has chosen to take a gap year after graduating with honors. During this period, James plans to complete a medical research fellowship before applying to MD/PhD, PhD, and MD programs.

Coding and Thematic Analysis

I conducted a total of nine interviews with URM T34 students who were engaged in undergraduate research. The analysis of the interview data followed a systematic, multi-stage coding process, which was essential for identifying meaningful patterns and themes that emerged from the nearly 600 quotes derived from the nine transcribed interviews. The coding process was iterative, moving through several rounds of examination, refinement, and synthesis. Each round

served to progressively synthesize the data into more coherent themes and subthemes, providing a deeper understanding of the phenomena under investigation. Saldana (2016) explains that "coding is not a precise science; it is primarily an interpretive act. As a result, the coding process is cyclical rather than linear, requiring the revisitation and refinement of codes to capture deeper or more nuanced meanings in the data."

First Round of Coding: Initial Reading and Familiarization

This first round of coding allowed me to gain a better understanding of the overall scope of each participants' response. The first step in the coding process involved a comprehensive, initial reading of the nearly 600 quotes drawn from the nine transcribed interviews. As suggested by Saldana (2016), this stage involves an initial "open coding" phase, where the researcher reads through the data without predefined categories or expectations.

During the initial coding phase, my primary objective was to thoroughly reacquaint myself with the data, as a significant interval of nearly a month had passed since the interviews were conducted. The goal was to immerse myself in the data to ensure I had a thorough understanding and to begin noting preliminary ideas and patterns that emerged during the first reading. By systematically reviewing and organizing the material, I aimed to gain familiarity with both the content and context of the responses, an essential step in ensuring a nuanced understanding of emergent themes and patterns within the data. This reflective immersion not only prepared me to engage with subsequent rounds of coding more effectively but also established a foundational comprehension, allowing for deeper analytical insights as the coding process progressed. This open coding phase allowed for a broad exploration of the quotes. I was able to better understand the nuanced responses from each participant that served to help me

better understand the responses and how I could potentially build upon the initial coding response.

Second Round of Coding: Emergent Codes and Labeling

The second round of coding entailed a more focused examination of the nearly 600 quotes, where I started to record specific codes that emerged from the second read. According to Saldana (2016), this stage involves "in vivo" coding or using the participants' own words as the initial codes, when possible, as well as creating conceptual labels that accurately reflect the meaning of each quote. Each quote was read with a more critical lens, identifying recurring words, phrases, or ideas that connected to the broader research questions. These codes were not predefined but rather emerged organically from the data, allowing for more flexibility in capturing new or unexpected patterns. This phase of coding was crucial in allowing me to categorize and label core concepts that informed further analysis.

Third Round of Coding: Charting Patterns

The third round of coding involved a deeper level of abstraction, where the codes generated in the second round were examined to identify patterns across the data. This step required me to group similar codes into clusters, looking for overarching themes or reoccurring concepts. Pattern coding, as described by Saldana (2016), was applied during this phase, where I grouped the data by identifying patterns or themes that reflected significant repeated ideas across the interviews. The goal of this phase was to organize the data in alignment with the research questions while identifying potential relationships among various codes. During this round of analysis, it became apparent that a significant portion of the data did not directly align with the research questions. However, this data holds value and represents findings that could be revisited in the future and utilized in other research studies. One notable example of such data are the

concept of "White passing." Although this data was compelling, a comprehensive exploration of the "White passing" concept fell outside the scope of the research questions. This stage of coding involved a constant back-and-forth between the data and the emerging patterns, allowing for refinement of the codes and their relationship to one another.

Fourth Round of Coding: Theme Development

In the fourth round, I took the patterns identified in the third round and began to develop broader themes that captured the central ideas emerging from the data. Saldana (2016) explains that theme development is an essential part of the coding process, and it allows the researcher to synthesize the information into meaningful and cohesive categories. Themes were not predetermined but were constructed inductively from the codes and patterns that had emerged earlier in the process. Each theme was carefully defined to ensure it accurately represented the underlying data and connected back to the research questions. In this phase, I conducted a thorough re-evaluation of the data to verify that the identified themes accurately reflected the nuanced perspectives of participants. This process was essential to capturing the complexity and depth of their responses in a valid and reliable manner.

Fifth Round of Coding: Subtheme Identification

The final round of coding involved a further refinement of the identified themes, in which I identified subthemes for each overarching theme. As Saldana (2016) notes, subthemes are often identified when researchers find that broader themes contain nuanced or distinct components that warrant further exploration. The goal of this stage was to ensure that each theme was sufficiently nuanced and that any subcomponents of those themes were appropriately acknowledged. I revisited the data and re-examined the relationship between themes and subthemes, ensuring that both the thematic structure and the individual elements within the themes were fully represented.

The identification of subthemes helped to further clarify the participants' experiences, offering a more granular understanding of the data while maintaining the integrity of the broader themes.

Table 2: Themes and Subthemes Research Question 1

Research Question 1: **What are the lived experiences of underrepresented minority (URM) STEM students engaging in research at NC State University, and how do these lived experiences play out in academics, graduate school aspirations, and career choice behaviors?**	
Themes	**Subthemes**
"I haven't seen my identity reflected in the people that work alongside me. But I'm hoping that with whatever I do in my future career that I can start to pave a path for people who have similar goals but may not feel like they can go into the same field because they don't see their identity mirrored." **Identity and Representation**	A. STEM Identity B. Feeling like a minority C. Diversity and representation
"Having supportive mentors that are just encouraging you to gain more knowledge is very monumental. That's what a good PI does. That's what a good graduate mentor does. That's what mine had done for me. She encouraged me to read papers and get more knowledge and really understand all this stuff and how it works." **Mentorship Dynamics**	A. Positive mentoring experiences B. Supportive and engaged principal investigators (PIs) C. Toxic mentoring D. Impact of toxic mentoring on confidence and engagement
"I am still learning." **Navigating Research Environment**	A. Lack of knowledge B. Learning and growth C. Overcoming barriers D. Strategies for addressing challenges in the research environment
"I know this is who I am, and this is what I want to do at this point." **Personal Growth and Resilience**	A. Perseverance and determination B. Gaining confidence and self-efficacy C. Self-reflection and development a. Growth in confidence through experiences in research.

Table 3: Themes and Subthemes Research Question 2

Research Question 2: **What are the barriers and what can be done to address the barriers and challenges to achievement for URM STEM Students engaging in undergraduate research?**	
Themes	**Subthemes**
"I would say that in any work environment, you're going to come across difficult people, I would say in a research environment, as a woman where it is so male dominated, it's harder than your average work environment. So, I definitely struggled with some of the power dynamics there. Because not only am I a woman, I'm also young as an undergrad." **Barriers to engagement**	A. Lack of research knowledge B. Gender differences and challenges
"I feel like the biggest barrier we all face is ourselves, telling ourselves we're not good enough, or we don't fit in there." **Self-perception and confidence**	A. Imposter syndrome B. Persistent feelings of self-doubt and inadequacy
"It's much more isolated, you do a lot more work on your own, it's independent, you set independent goals, it's a lot harder that way to do it, if you don't have motivation." **Social Dynamics**	A. Isolation vs. Independence B. Welcoming vs. unwelcoming space C. Collaboration and competition

Comparison Coding with Machine Intelligence

During the first few rounds of coding, I conducted a comparative code analysis against codes that were created using ChatGPT. ChatGPT 3.0 is a large language model artificial intelligence (AI) also referred to as Machine Intelligence. ChatGPT and similar large language models provide unique opportunities for comparative coding analysis, allowing researchers to 'generate rapid, contextually nuanced interpretations of qualitative data, which can be compared across codes to reveal patterns' (Guest et al., 2022), enhancing the depth and efficiency of thematic exploration. There are other data software programs like NVivo and ATLAS.ti that are designed to code text, audio, and visual data that I could have used instead of ChatGPT. Though the use of ChatGPT in scholarly research is a topic of ongoing debate, I opted to incorporate it as a supplementary tool following an extensive manual coding process based on Saldana's (2022) guidelines for qualitative coding and its accessibility. The rational for using ChatGPT was based on the experience of research fatigue encountered during the coding process. Analyzing and deriving meaning from nearly 600 quotes proved to be a daunting task. Using ChatGPT provided reassurance that the manual coding process was aligned with the patterns identified by machine intelligence, thereby validating the interpretive approach.

Morgan (2023) explores how tools like ChatGPT present innovative possibilities in qualitative research, particularly in analyzing large datasets such as interview transcripts. ChatGPT can assist researchers in scanning and categorizing data based on themes, which can expedite the traditional manual coding process. According to Morgan (2023), AI modes like ChatGPT hold the potential to identify patterns across a large dataset with efficiency, supporting qualitative researchers in coding tasks. I used ChatGPT alongside the insights gained from

Saldana's (2022) framework to ensure a nuanced interpretation of the codes, as well as the themes and subthemes developed during the analysis.

This approach helped blend AI-assisted coding with the depth and complexity required for qualitative analysis, drawing on established methods for coding and theme identification (Saldana, 2022). By integrating both AI tools and manual interpretation, I was able to refine the thematic analysis process while maintaining academic rigor. It is essential that AI tools are used in conjunction with human expertise to ensure that the identified themes are valid and meaningful in the context of the research questions.

AI can be used to code qualitative data, helping to identify patterns that might be less obvious to human researchers, thus augmenting the analysis with a broader range of insights (Birks et al., 2023; Mckee, 2022). AI-supported thematic analysis combines traditional qualitative analysis methods with artificial intelligence (AI) technologies to enhance the identification, coding, and categorization of themes in qualitative data. Thematic analysis itself is a widely used approach for analyzing patterns and themes within textual data, often through a manual or semi-automated process. By integrating AI tools, researchers can automate parts of the process, thus improving efficiency, consistency, and scalability when analyzing large datasets.

Thus, as Morgan (2023) suggests, AI tools like ChatGPT are poised to complement traditional qualitative methods, offering a more systematic and less time-consuming approach to data analysis. However, careful consideration of prompt design and the integration of human judgment remains essential to achieving meaningful outcomes. The manual codes that I created closely aligned with the ChatGPT codes. See Table 2 for side-by-side comparison of the manual codes that I developed from the responses to three of the interview questions versus the codes that were generated by messaging ChatGPT in three different instances to create codes from the

responses to the interview questions 4: What has been your experience in the research setting?; interview question 6: Can you describe your mentorship relationships you have cultivated?; interview question 7: Discuss your confidence in your ability to successfully navigate undergraduate research.

I mainly relied on the manual codes that I created to develop the themes and subthemes presented in this study as ChatGPT missed some of the intricacies of the data. The manual coding process presented a more nuanced response to interpreting the data, identifying codes and patterns and thus the development of themes and subthemes. In scholarly contexts, a nuanced interpretation may focus on understanding the multiple layers of meaning within data, such as recognizing subtle themes, recognizing contradictions, or exploring complex emotions or perspectives that a more simplistic analysis might overlook (Merriam & Tisdell, 2016; Braun & Clarke, 2006).

Table 4: Interview Question Response with Comparative Coding 1

QUESTION	MANUAL CODES	CHATGPT CODES
WHAT HAS BEEN YOUR EXPERIENCE IN THE RESEARCH SETTING?	Helpful mentors Gender Gender differences PI influence Research hierarchy Support Confidence Self-efficacy Isolation Positive experience Independence Toxic mentoring Learning Difficult people	Peer support Graduate student mentorship Effective mentorship Poor mentorship Gender dynamics Research confidence Isolation Self-motivation Influence of the PI Hierarchical challenges Power dynamics with mentors
CAN YOU DESCRIBE THE MENTORSHIP RELATIONSHIPS YOU HAVE CULTIVATED?	Mentoring and learning Gender Mentoring respect Communication Differences Building trust PI driving force Good mentoring Confidence Independence Asking for help Growing as a researcher Self-efficacy Social Mentoring style Positive mentoring	Supportive mentorship Open communication and feedback Independence and professional growth Personality compatibility Role of diversity and gender in mentoring Professional and personal development Challenges in mentorship relationship Collaborative atmosphere

Table 5: Interview Question Response with Comparative Coding 2

QUESTION	MANUAL CODES	CHATGPT CODES
DESCRIBE YOUR CONFIDENCE IN YOUR ABILITY TO SUCCESSFULLY NAVIGATE UNDERGRADUATE RESEARCH?	Confidence Imposter syndrome Perseverance Passion Doubt Overthinking Lab presence Not good enough Insecure Self-esteem Science identity development Intimidation Establish credibility Pursue graduate school Committed Independence Encouraging Presenting own research Ownership	Imposter syndrome and self-doubt Growth in confidence over time Mentor support and encouragement Independent skill development Learning from mistakes and resilience Overcoming challenges and building resilience Presentation and articulation skills Passion and long-term commitment Establishing a research identity

Conclusion

The coding procedure was guided by a combination of inductive and deductive approaches to ensure the richness of the data, and the research questions were addressed effectively and efficiently. The overall coding involved a level of inductive coding. Inductive coding is entering the analytic enterprise with as open a mind as possible-a "learn as you go" approach that spontaneously creates original codes the first-time data are reviewed (Saldana, 2022).

In the initial review of the quotes, I reviewed notes that I took during the interview and immediately after the interviews wrap up that addressed the overall feel of the interview and any emotions that I felt that came across during the interview. Emotion coding is appropriate for virtually all qualitative studies, but particularly for those that explore intrapersonal and interpersonal participant experiences and actions, especially in matters of identity, social relationships, reasoning, decision-making, judgment, and risk-taking (Saldana, 2022). From my notes and documented observations, I reflected on the emotions that came across from each participant during the interview process. In this process, I read and re-read each transcript to understand each story and find emerging themes from those stories.

During the five rounds of coding, I was able to move from a broad exploration of the data to a detailed, nuanced interpretation of the participants' experiences. The coding process, as outlined by Saldana (2016), is an iterative and flexible approach that requires constant revision and refinement to ensure the accuracy and depth of the analysis. In continually revisiting the data and adjusting the codes, themes, and subthemes, I was able to develop a coherent and comprehensive framework that accurately reflects the complex and multi-layered interview data. The iterative nature of my coding process highlights the importance of ongoing engagement with

the data to ensure that the final themes and subthemes reflect both the participants' voices and the research objectives.

The extensive coding process involved identifying themes and subthemes. This process coupled with conversations and collaborative efforts with the inquiry partners allowed me to address the third research question - What programmatic efforts can be identified and implemented to mitigate the challenges and support underrepresented minority (URM) students engaging in undergraduate research? The process of identifying, developing, and implementing the *Advance Together* curriculum aligned closely with the objectives of this research study while also providing valuable tools for the third and final NIH grant resubmission. Feedback from the NIH on the previous two resubmissions highlighted a significant gap in support and professional development within the NC State T34 program. Upon analyzing and communicating the interview data, the inquiry team recognized the need for enhanced support for undergraduate researchers.

Although the data underscored the importance of prioritizing graduate student mentoring and training, the decision was made to focus on creating a programming model specifically for undergraduate students. This focus stemmed from the accessibility of these students and the clear need for an intervention to strengthen the grant resubmission. In response to Research Question 3, two programmatic actions were identified, developed, and implemented: a diversity workshop that focused on conflict management and cultural competence and the development of a trainee curriculum that supplements their research experience.

Research Question 1 - What are the lived experiences of underrepresented minority (URM) STEM students engaging in undergraduate research at NC State University, and how do

these lived experiences play out in academics, graduate school aspirations, and career choice behaviors?

Theme 1 – Identity and Representation – *Identity and representation encompass the interconnected themes of STEM identity, the experience of feeling like a minority, and the broader concepts of diversity and representation within academic, research, and professional spaces.*

Both identity and representation are pivotal in shaping the experiences and outcomes of URM STEM students. Identity and representation influence not only how students experience the challenges and opportunities within STEM disciplines but also how they envision their futures in academia and professional careers. Identity refers to how individuals perceive themselves and how they are perceived by others in a social, cultural, and institutional context. Some students expressed the fact that their identity greatly influenced the decision to major in STEM. Dimitry explained:

> I grew up in Nigeria. And I think it was always a big thing (STEM) over there. Shortage of doctors. Shortage of people that major in STEM. And it always just appealed to me to become someone who was involved in that.

In the case of URM STEM students, identity encompasses multiple facets, including racial, ethnic, gender, and socioeconomic dimensions, and it can influence how students navigate and experience higher education and research environments (Tatum, 2017). For URM students, identity may intersect with their experiences in STEM fields, potentially impacting their sense of belonging, academic self-concept, and aspirations for graduate school and careers. The concept of "intersectionality," introduced by Crenshaw (1991), is crucial here, as it underscores how

different aspects of identity (such as race, gender, and socioeconomic status) intersect to create unique lived experiences, often leading to challenges in predominantly White, male-dominated fields like STEM. This concept was apparent for one URM STEM student who addressed feeling like a minority. Zara stated:

> I think I definitely feel that I am a minority. I feel like it depends on what part of that I feel. So, in Biomedical Engineering, I feel like the ratio of female to male is a lot more balanced than in other types of engineering like mechanical and electrical. So, in that regard, I don't feel it as much. But in terms of working in my lab, or even now applying to PhD programs, I've been told that as you move up in your professional career that your presence as a minority is felt even more because the diversity decreases as you move up. There are no minority graduate students in my lab. There is one post doc, but not one of the PhD students is a minority.

Students continued to express feeling like a minority at NC State University and in the undergraduate research setting and Alex conveyed: "The amount of diversity within the program was very low; it was very noticeable, and it was the thing that I talked about all the time with my mom my first year here." Participants also notice the lack of diversity within the campus population and Alex went on to explain:

> I do understand that this is a PWI. But for me to be in a chemistry lecture with 300 people and there are only six black people. It's crazy. It's gotten better over the years. I can see a lot more representation now. But, you know, that took time.

URM students who fall under the URM category as it relates to their race certainly are aware of the lack of racial representation in certain spaces and Dmitry stated:

> There's a lack of black students specifically in STEM research. Even in the biomedical engineering department, we only have one person in our department (faculty) who is African American. So that just shows you what the field is like.

While students do notice how different underrepresented identities manifest in the research setting, for a few students in this study they tended to acknowledge the female representation in their research space as Zoe explained: "I feel like the lab is more female dominant than male dominant." Being able to see women in the research setting had an impact on them and believing that they could be successful as articulated Zara described: "I am seeing other women succeeding and succeeding well and that is really encouraging; as it relates to racial minorities, I'm not really seeing that a lot." This notion goes back to intersectionality as it relates to the lived experiences and how these experiences are internalized.

Many of the participants conveyed that STEM has always been present as Alex articulated: "STEM identity has basically been a part of my entire life." Understanding representation and how URM students see themselves as STEM students and researchers is key to making meaning of their lived experiences. For the URM STEM participants identity and representation are important and it fuels their desire to persist as Zara stated:

> I haven't seen my identity reflected in the people that work alongside me. But I'm hoping that with whatever I do in my future career that I can start to pave a path for people who have similar goals but may not feel like they can go into the same field because they don't see their identity mirrored in the people in the field already.

URM students have a strong sense of representation and feel that it is important for that representation to be important within their communities of being. The feeling extends to URM

students who wanted to make an impact for not only themselves but their families and communities. Zara elaborated:

> My parents didn't really have the opportunity to pursue everything they wanted because they basically moved halfway across the world. I knew that I wanted to pursue something that I can make a difference in some way, shape, or form, but also pursue whatever I was passionate about, since I know they didn't have the opportunity, but they were giving it to me and my siblings, so I wanted to take advantage of that.

Representation in this research refers to the visibility and presence of the participants in STEM and undergraduate research. In this case, it is concerned with the presence (or lack thereof) of URM students in STEM fields, including their involvement in undergraduate research and their mentorship and academic support systems (Harper, 2012). Representation also plays a role in how students perceive their potential and whether they see themselves as part of a broader academic or professional community. Alex stated:

> My mindset has always been that if there aren't people like me there, I can go there. I can do it. I think if I have the capabilities of doing something I should go and pursue it, regardless of what the playing field looks like.

A lack of representation can lead to feelings of isolation and a diminished sense of belonging, whereas greater representation can enhance students' self-efficacy, increase access to mentorship, and foster a supportive academic environment (Dugan & Komives, 2010). For James, representation and perceived representation was a factor. As am Asian male he recognized that his gender and racial identity are overrepresented in STEM and his URM identity is the invisible identity that impacts his undergraduate research experience. Through understanding identity and

representation, this research can illuminate the broader systemic and interpersonal factors that contribute to or hinder URM students' success and aspirations in STEM.

Theme 2 – Mentorship Dynamics – *Mentorship dynamics refer to the varied relational interactions between mentor and mentees that can significantly influence mentees' confidence and engagement*.

Mentorship dynamics in this research study refers to the interpersonal and structural elements that shape the mentor-mentee relationship, including how mentorship impacts the overall research experience, how URM students construct a science identity, academic and research confidence, professional development, and aspirations for graduate school and career choices. Good mentoring is impactful as communicated by Alex:

> Having supportive mentors that are just encouraging you to gain more knowledge is very monumental. That's what a good research PI does. That's what a good graduate mentor does. That's what mine had done for me. She encouraged me to read papers and get more knowledge and really understand all this stuff and how it works.

Christine spoke to the PI in the research setting: "the PIs set the tone." Many of the students spoke to the PIs presence in the research setting. The open-door policy and consistent PI presence foster a welcoming atmosphere in the lab, promoting communication and enabling students to seek guidance and build rapport. The response from Dmitry illustrates the observed supportive mentorship culture within NC State's research environment, where principal investigators (PIs) are described as actively engaged and accessible:

> The PIs here at NC State are a lot more hands on and present than what I've seen at other universities and other programs. And I'm appreciative of that as well. They're always in

> their offices, anytime I'm walking into the lab. I feel like the doors are always open, I can just go in, ask them questions, or just talk to them about whatever it is.

The student's perspective emphasizes the value of approachable mentorship and how it positively shapes their research experience, reinforcing a collaborative and supportive learning environment.

Participants feel that PI mentoring is important and observing positive PI mentoring has a significant impact on the experience of URM STEM students. Stacy explained:

> PIs really push for not just their graduate students, but the undergrads to get the opportunity to grow as well. So, I've never felt like I was just an undergrad, I don't have a voice or the work I'm doing in the lab doesn't matter. They've always made sure that we feel welcomed in the lab, and that the work we're doing is appreciated as well.

For URM students in STEM, mentorship dynamics are often influenced by mentors' understanding of and sensitivity to the unique challenges these students face, such as racial or cultural marginalization, gender bias, stereotype threat, and a potential lack of representation within the field (Byars-Winston & Rogers, 2019). Students can recognize when a mentor is aware of things that may be going on with them as it relates to their underrepresented identities. Stacy elaborated on this in talking about her mentor:

> He understands that being a woman in a field like chemistry is extremely difficult and he's been kind of lenient and understanding. I feel like my mentor is a great female supporter. He just wants his undergrads to do well, and you can just tell he doesn't want to make anyone feel in a negative type of way.

PIs and graduate level mentors play a key role in how URM students view the world of research and their future engagement. In the case of toxic mentoring this reality can have

damaging effects on URM students and their pursuits as undergraduate researchers and beyond. Carla spoke of the situation with her original research placement: “This mentor was very sexist and racist, and he made remarks and things ended ugly.” Two of the five female participants in this study had to identify another research lab due in part to toxic male mentors. Christine explained:

> There can be negative research experiences in any work environment. You’re always going to come across difficult people at work. But I would say that in the research environment as a woman where it is so male dominated, I think it is harder than let’s say the average work environment. So, I struggled with some power dynamics there. Because not only am I a woman, I’m also young, as an undergrad.

Carla spoke to her male mentor consistently blocking her from truly engaging in research. This is a significant challenge that some female undergraduate researchers face when mentorship dynamics become restrictive rather than empowering. Such dynamics can limit autonomy and hands-on learning, essential for developing research skills and confidence. For Carla, the lack of opportunity to actively engage in research led to frustration and a sense of stagnation, highlighting the importance of allowing mentees the space to independently experiment, make mistakes, and learn by doing. Carla explained:

> He was not a great mentor. Like I did try to do things on my own, but I wasn’t allowed to. Imagine spending twenty hours just standing behind somebody else doing things. It’s like my brain is not learning because I’m not touching anything. So, it was just incredibly boring. And like nothing was working.

It is worth noting that both female undergraduate researchers elected to highlight the positive aspects of their research experiences and did not heavily focus on the male mentors and

unfortunate situations that resulted in both female students being moved to other research assignments. Both situations and the toxic interactions that ensued ultimately warranted formal investigation by NC State officials. In both cases, the female researchers expressed a desire for these male mentors to retain their positions, even though these situations raised concerns about mentorship quality and professional conduct. This response underscores the complex dynamics that may influence perceptions of mentorship, particularly where power imbalances exist, and highlights how students may navigate professional relationships by focusing on positive aspects even within problematic contexts. In reflecting upon the outcome Christine responded:

> I think now moving forward in my career as it progresses, I think I'm better prepared to deal with more difficult people that I will work with, and men in STEM. I feel a lot more comfortable in explaining my boundaries and being just a little more assertive with my ideas and decisions.

Mentorship in the context of the research setting typically involves providing both technical guidance in research skills and social support, which can contribute to a mentee's sense of belonging and self-efficacy in STEM disciplines (Graham et al., 2013). Effective mentorship may include role modeling, offering constructive feedback, encouraging independent research, and fostering networks that support students' growth beyond their undergraduate years (Packard, 2016). For URM students, these dynamics can be particularly influential, as positive mentorship experiences have been shown to mitigate feelings of isolation and imposter syndrome, ultimately enhancing their confidence in pursuing further academic and professional goals (Alvarez, Blume, Cervantes, & Thomas, 2009).

Effective mentorship involves mentors proactively addressing implicit biases and creating inclusive lab or research group environments. Such dynamics not only aid in skill

development but also support URM students in navigating the complexities of their identities in STEM, helping to bridge the gap between undergraduate experiences and aspirations for graduate education and professional careers.

Theme 3 – Navigating the Research Environment – *Navigating the research environment involves developing the skills, adaptability, and resilience needed to effectively engage with the complexities and demands of the research space.*

For URM students, navigating the research environment within predominantly White institutions presents distinct challenges and requires adaptive strategies. Often, URM students encounter an academic culture that may not fully reflect their experiences or backgrounds, necessitating the development of social and professional navigation skills to access resources, mentorship, and support systems effectively (Garvey, 2018). Engaging in research within such spaces can compel URM students to find pathways to establish belonging, leverage institutional networks, and build confidence in predominantly White settings. These efforts can foster resilience and equip URM students with skills essential for academic and career success (McGee & Bentley, 2017).

Navigating the research environment refers to how URM students understand, interact with, and make progress within the academic research setting at NC State University. This includes learning the norms, expectations, and practices within their research labs, as well as managing challenges related to both academic and social dynamics. Many of the URM participants indicated the lack of knowledge they had as it relates to undergraduate research. Cassidy stated: “So freshman year, I honestly didn’t know anything about undergraduate research.” This lack of knowledge carried into the actual research setting for Cassidy: “I didn’t

know in the beginning how in-depth and detailed research really is." Participants reported that their initial lack of familiarity with research processes and expectations left them without a concrete sense of what undergraduate research would entail or how it would impact their academic experience. Participants talked about uncertainty and how this uncertainty was a result of their lack of or limited exposure to research environments. The hesitancy to navigate the undergraduate research environment early on often can stem from limited prior exposure to research environments, which can shape students' perceptions and preparedness as they begin their research journey. Zoe reflected on this:

> I didn't have an impression of the lab before I joined, just because I didn't have any idea what it was like in that kind of space. But I did attend a lab meeting prior to joining the lab to see if I liked it. And all the people there just came off as being nice and welcoming. And I guess that's what drew me into the lab.

The welcoming atmosphere that some URM students experience not only influenced their initial decision to join a particular research lab but also helped ease the transition into an unknown research environment, reinforcing the importance of supportive social dynamics in encouraging learning, engagement, and retention among URM researchers.

For many URM students, navigating the research environment involves not only acquiring technical skills but also adapting to a culture that may be unfamiliar or even unwelcoming, given the underrepresentation of minority identities in STEM fields (McGee, 2016; Ong et al., 2011). Many of the participants reflected on the undergraduate research experience and the challenges to learning, growing, and overcoming barriers. Alex explained:

> I think the most challenging thing is not knowing. And the biggest barrier is the understanding that you lack knowledge. It's very hard to go in and not know anything and be okay with not knowing especially when you are on a project with a bunch of people who know stuff. You may feel inferior and it's kind of hard to navigate.

Navigating the complexities of knowledge gaps in the undergraduate research setting can be challenging, especially when surrounded by more experienced peers and graduate students. As Carla stated during her interview, she did not have a clue on what was going on in her first few research meetings, she indicated it was like hearing a foreign language. Settling into the research environment was a challenge for some of the participants. This challenge often requires the individual to embrace a mindset of continuous learning and intellectual humility, which, although difficult at first, can ultimately foster resilience and growth within the research environment. Dmitry addressed this challenge:

> Do I really want to do this? Is this mentor thing working? But there are people out there that are not minorities that want to help you no matter what you look like. If you have the drive, the skill, the willingness to learn, pursue what you want to. So, I don't think it's really a problem.

By recognizing and gradually addressing these knowledge gaps, students can transform feelings of inferiority into motivation for skill development and mastery over time, gradually building confidence and competence in their academic pursuits. Christine spoke about how her confidence came into being:

> I really pushed myself during the summer. I was pushing myself to make sure that I'm doing the best for my team and make sure I'm learning the most that I can from this

> experience. And because of that, you know, I became a stronger researcher. And now I'm confident in my abilities. And I'm more willing to talk about my research with people who are experts in the field. I'm more than willing to be wrong. And I can recognize that I can make mistakes and mistakes are meant to be learned from.

Through this intensive period of growth, this URM student not only enhanced their technical skills but also cultivated resilience and adaptability, which are essential qualities in research. This experience left them more confident in engaging with experts, opened themself up to constructive critique, and allowed them to embrace continuous learning and viewing mistakes as valuable opportunities for development. This is certainly a big part of the learning and growing process for URM students because they often do not embrace making mistakes or not knowing something early on. As Zoe explained: "I am shy and approaching someone and asking for something from them when I really don't know them felt wrong and awkward in the beginning." For this URM female student receiving mentor support was a challenge as she began to navigate the research setting. Approaching her graduate level mentor for assistance felt intimidating and uncomfortable, as it conflicted with her reserved nature. Over time, however, the student began to see these interactions as essential opportunities for growth, learning to navigate initial discomfort to build meaningful professional connections. Furthermore, Zoe equated this feeling to her gender: "I don't know if this is because I am a woman, I don't want to take things from people without having something to give and I would say that has been a big barrier." Cassidy alluded to having feelings of guilt or doubt when having to ask for support in the research setting:

> I don't want to bother them especially because I'm not in the lab as much so sometimes I feel like they are saying she is going to ask me to do something for her and then she is

> going to leave earlier than me. I don't want to upset them and that is a big issue. A big issue is that I don't have a personal connection in the actual lab to get certain support when I need it.

The student describes the challenge of limited lab presence, expressing concern that this may hinder their ability to seek support without appearing burdensome to peers who spend more time in the lab. This perceived lack of a personal connection within the lab can lead to hesitancy in requesting assistance, potentially affecting their access to needed resources and support for their research tasks. This sentiment reflects broader issues for underrepresented students in gaining equitable access to mentorship and integration within research spaces, which are crucial for fostering a sense of belonging and support (Gibbs & Griffin, 2013).

URM students often face the challenge of strategically navigating the research environment to effectively leverage available relationships and resources. As students develop a clearer understanding of their roles and apply targeted strategies for engagement, they increasingly gain access to the academic and professional advantages that undergraduate research offers. This is something that URM students reported as it relates to overcoming the barriers associated with navigating the research environment. Stacy spoke to her progression:

> I've progressed so much since I first started in the lab. I remember being kind of scared to run anything on my own. Because I was afraid to mess up. And now I have confidence. I can learn. I can develop skills; I can get better. And that's the goal. I know that the research team needs to get things done. I have a goal I want to meet, so I'm going to work towards it.

URM students often face the challenge of learning how to navigate the research environment effectively to maximize available relationships and resources. As students gain clarity about their roles and implement strategies to enhance engagement, they begin to experience the academic and professional benefits of participating in undergraduate research (Thiry & Laursen, 2011).

Key components of navigating the research environment include building relationships with peers and mentors, understanding hierarchical structures, managing imposter syndrome, and sometimes confronting stereotypes or biases. For URM students, successfully navigating these challenges is often essential for developing a strong research identity, building confidence, and setting the foundation for long-term academic and career aspirations (Hurtado et al., 2009). A supportive research environment, where students feel included and valued, is crucial for fostering a sense of belonging and facilitating a positive experience that encourages them to pursue further studies or careers in STEM (Byars-Winston et al., 2015).

For URM students, navigating the research environment within predominantly White institutions presents distinct challenges and requires adaptive strategies. Often, URM students encounter an academic culture that may not fully reflect their experiences or backgrounds, necessitating the development of social and professional navigation skills to access resources, mentorship, and support systems effectively (Garvey, 2018). Engaging in research within such spaces can compel URM students to find pathways to establish belonging, leverage institutional networks, and build confidence in predominantly White settings. These efforts can foster resilience and equip URM students with skills essential for academic and career success (McGee & Bentley, 2017).

Theme 4 – Personal Growth and Resilience – *Personal growth and resilience embody the process of building inner strength, and self-awareness to overcome the challenges and achieve continuous development.*

Personal growth and resilience refer to the ways in which URM participants develop self-confidence, adaptability, and a strong sense of perseverance through their undergraduate research experiences. Personal growth encompasses the process by which students build essential skills, such as problem-solving, critical thinking, and the ability to work independently. It also includes the development of a positive research identity and a clearer understanding of their academic and professional goals (Chang et al., 2014). Through the research experiences URM students grow and begin to recognize themselves as researchers making an impact, "I know this is who I am and what I want to do at this point." All participants in this study reported that their involvement in undergraduate research significantly contributed to their personal and academic growth. Christine commented:

> It (training grant experience) really solidified my ability to do independent research. And I feel like my graduate student mentors and PIs, they all gave me the opportunity to really explore research from an independent perspective and a learning perspective. So, I just had the opportunity to learn so many techniques and get involved with a lot of different projects here.

This URM student emphasized that their undergraduate research experience signifies growth, and the experience significantly strengthened their capacity for independent research. With support from graduate mentors and PIs, they were able to explore research autonomously,

acquire a range of techniques, and participate in diverse projects, all of which fostered both skill development and a deeper learning orientation.

Resilience, as a theme in this research study, reflects students' ability to overcome the unique challenges and potential setbacks they may encounter in the STEM research environment. For URM students, resilience often involves navigating barriers such as implicit bias, stereotype threat, or feelings of isolation, which are more prevalent for underrepresented groups in STEM (McGee & Bentley, 2017; Estrada et al., 2018). These experiences can be particularly demanding and may require students to draw on internal motivation, support from mentors, and community connections to persist and thrive. URM participants described encountering challenging experiences in the research setting and navigating through associated negative emotions. Carla spoke of her experience:

> I was really demoralized. And it affected me a lot in my cognitive processing. I was just anxious. I was a mess. In my head I was not good at whatever I was attempting to do. I was very demoralized and that hit, especially for somebody that typically things come easy to. For months doing something that doesn't work and not being able to figure it out what was wrong was very frustrating. I began to think these people have given me a scholarship and now I'm useless. I'm not producing good data, and I thought I would be kicked out of the program.

Carla expressed deep demoralization and anxiety in the research environment, which significantly impacted her cognitive processing. Used to succeeding with relative ease, she struggled with persistent challenges and a lack of progress, leading to frustration and self-doubt. She worried about her perceived lack of productivity and feared losing her scholarship or being

removed from the program altogether. Carla reflected on a period when she was close to abandoning both her research endeavors and her pursuit of graduate school:

> You guys (T34 administrators) lifted me up a lot. Because I was not feeling great about myself. And then, you know, explaining that this is a normal part of research. And then I hear from the PI, yes, I believe in you. And I was never sure about that relationship. I was very insecure about it, and I was thinking he was about to kick me out.

Together, personal growth and resilience contribute to the students' ability to set and achieve academic and career goals, often fostering a stronger commitment to graduate education and STEM careers. The development of these qualities is critical, as they enable URM students to not only adapt to but also excel within challenging research environments and ultimately increase their likelihood of long-term success in STEM fields (Graham et al., 2013). It is important for administrators to understand how experiences can impact students.

Research settings can present unique stressors for URM students, who often contend with feelings of isolation, stereotype threat, and imposter syndrome at higher rates than their peers (Cokley et al., 2013). These stressors, if left unaddressed, can lead to self-doubt, diminished performance, and ultimately, attrition from research and academic pathways (Gibbs, 2014). Consequently, regular communication and proactive monitoring by mentors and faculty are essential to support these students' personal and professional growth.

Research Question 2 - What are the barriers and challenges to achievement for URM STEM students engaging in undergraduate research, and what can be done to address these barriers and challenges?

Theme 1 – Barriers to Engagement – *Barriers to engagement refer to the various obstacles that hinder active participation and full involvement, shaped by factors such as limited prior knowledge and differences in the opportunities or challenges faced by individuals.*

Lack of research knowledge

Barriers to engagement refer to the complex, often interconnected challenges that URM STEM students encounter in accessing and succeeding within undergraduate research opportunities. Just like well represented students, many URM students entering higher education have a limited understanding of undergraduate research. A few participants in the study stated they had very little knowledge about research and no experience. Stacy stated: "When I got my acceptance it was so rewarding because I literally had no faith in myself, and I had no research experience." Furthermore, some students pointed out that they were not prepared in their initial attempts to engage in undergraduate research. Alex explained his first attempt:

> My first time trying to engage in undergraduate research as a first-year student was not fruitful. I think it had a lot to do with the fact that I was a first-year student. I was not very knowledgeable about anything. So, I didn't really come with much. So, the conversation basically went nowhere.

URM students with an interest in undergraduate research can benefit significantly from programs such as the T34, which provides structured entry points into research for students who demonstrate both an aptitude for STEM and characteristics associated with successful transition to graduate-level study. These programs offer valuable opportunities for skill development, mentorship, and early exposure to research environments, all of which are critical for fostering academic/research growth and supporting URM students in their pursuit of advanced degrees.

Sometimes, supporting URM STEM students can be as simple as planting the idea that undergraduate research is an achievable goal. Zoe stated: “I saw the T34 opportunity in an email my freshman year” Stacy disclosed: “I received the emails regarding the T34 and read through them. I was like this could be something for the future, like it’s worth a shot.”

As discussed, knowledge gaps regarding research norms and expectations can be a barrier for URM students who are prime candidates for undergraduate research. Many URM students enter research settings without prior exposure to academic research culture or essential research skills, leaving them feeling uncertain about their capacity to contribute effectively. This lack of familiarity may contribute to hesitancy in seeking research opportunities, particularly in institutions that do not proactively introduce students to research as part of the undergraduate experience (Bangera & Brownell, 2014). Without early mentorship or formal support in research methodologies, students may face difficulty understanding complex procedures, scientific language, and unspoken expectations—factors that can lead to disengagement or lower confidence.

Exposure to research certainly eliminates the knowledge barrier and URM students begin to understand the importance of undergraduate research in getting them to the next level. Zara explained:

> Doing research and having a well-developed thesis that you have worked on is important. And just being able to move up in hierarchy requires a high-level education and getting to that higher level education requires prior experience at the undergraduate level. Although there are PhD programs that take people who have minimal research experience, it does

help to have your foot in the door before you start your PhD. So that is why I wanted to start undergraduate research.

Gender differences and challenges

Another barrier highlighted by URM participants in this study was the influence of gender-based challenges in the research environment. Four of the six female URM participants reported that their gender, or the observed impact of gender on others, affected their experiences in the research setting. Zara stated: "I feel like some grad students have prejudice towards women and I would also say in terms of race and gender I can see a greater degree of mistrust." This is a challenge that impacted the research experience for URM female students. Christine explained:

> I feel what I struggled the most with, especially in the research realm is just being female. I feel like the research academic environment is very male dominated. There are very few female PIs, especially in the STEM field.

For female students, especially women of color in STEM, gendered stereotypes and biases may contribute to feelings of isolation and inferiority within research environments often dominated by male peers and mentors (Espinosa, 2011). Carla reported her feelings in the chemistry research lab in which she was assigned:

> I felt like I did not have a place. In the lab it was accentuated by the fact that nobody else in there looked like me. Like there was nobody in there I could relate to even the one woman that was there.

What is also worth noting in this study is that one of the male participants reported a "reverse" gender-based challenge with a female PI in his research setting. Alex spoke to his gender-based observation:

> She definitely preferred the women in the lab. Like okay that's fine. That's cool. We can address that later. The main thing is how can I fix what I'm doing right now. So, instead of immediately jumping the gun and assuming and sticking with that and keeping that above my head and having that basically keep me down and me feel inferior I just took away the barrier.

Unlike some of the female participants this male participant recognition of the gender-based challenge gave him fuel to assert himself almost immediately. Some female students in this study did not internalize the gender-based challenges early on and some of them upon recognizing the situation did not advocate for themselves or strategize a plan of recourse. For two of the female URM female participants, the circumstances became so challenging that reassignment to a different research lab was necessary.

Gender-based challenges were real for the participants in this study. Gender-based challenges faced by URM women in STEM research were described by the participants in this study. Many scholarly sources indicate that URM female undergraduate researchers experience challenges, including stereotype threat, limited mentorship opportunities, and systemic bias, all of which can hinder their academic and professional trajectories. Gender disparities in STEM fields often intersect with racial and ethnic minority status, compounding challenges and contributing to feelings of isolation and marginalization (Settles et al., 2016; Ong et al., 2011).

For some of the URM female participants in this study, these experiences contributed to increased self-doubt or "imposter syndrome," wherein students question their sense of belonging and perceived competence within the research community. Gender dynamics can also affect access to mentorship and networking opportunities, as female URM students may find fewer role models who can provide both gender and cultural understanding, further limiting their engagement and persistence (McGee & Martin, 2011).

URM female students can eventually find a way to navigate the gender related challenges that they face in the research setting and as previously discussed many of the female students learn from these challenges. Christine added:

> I think there is a very distinct difference between grad students and undergrad students and sometimes male mentors and female undergraduate researchers. So, it's not just I am a female, I am also at a lower academic rank. So that situation just compiled and made me more susceptible to working with some difficult people. But I feel like at the end of the day, I am still grateful for the experience because it helped me pivot into a new and more rewarding project. I was able to learn a lot more, and I was able to navigate a fairly difficult situation and come out.

It is important that research environments mitigate the gender-based challenges for the female students and when this occurs female students noticed and are empowered. Stacy stated:

> I did not notice any difference in the way genders were treated. I would say it was the same between the two. The PI would offer feedback based on the chemistry and nothing else.

Addressing these barriers requires a nuanced approach that includes dedicated mentorship, targeted research training, and institutional support to help URM students navigate both the technical and social challenges of research environments. Providing structured research preparatory programs, as well as fostering inclusive lab cultures where diverse identities are valued, can improve URM student engagement, reduce isolation, and enhance their academic and career trajectories in STEM (Chemers et al., 2011).

The URM participants in this study have seen remarkable success in their undergraduate research endeavors, but these successes have also been coupled with challenges. These challenges and barriers stem from a variety of structural, social, and personal factors, each of which influences students' ability to fully participate and thrive in research environments. Most students do learn to navigate these challenges, but it does require a significant amount of effort from multiple entities including not just the student, but the multi-level mentors and program administrators. URM female participants in this study recognized the gender challenges and most learned how to overcome these challenges as Zoe stated: “Being a woman has definitely made me advocate for myself more.” Their awareness has allowed them to navigate the landscape and have a voice as Christine explained: “I’ve had to be a little more assertive when working with male peers.”

Theme 2 – Self-perception and Confidence – *Self-perception and confidence relate to an individual’s sense of self-worth and belief in their abilities, which can be influenced by recurring feelings of imposter syndrome, doubt, and inadequacy.*

Self-perception and confidence refer to how URM participants view their own abilities, identities, and fit within the academic research environment. In this study, URM students

gradually began to develop a sense of belonging within the research setting as one student shared their sentiments regarding being an undergraduate researcher. Alex stated:

> You deserve to be here. Just don't let someone tell you that you don't deserve to be here, because you're just as good as anyone else.

URM students not only internalize this belief for themselves but also strive to embody and convey this attitude to their peers. Dmitry explained:

> I've always felt confident in my own shoes, in terms of being a minority, and always tried to encourage people who are minorities who want to pursue something like research to go for it.

These aspects of self-concept are pivotal, as they shape students' engagement in undergraduate research, influencing both their academic persistence and professional aspirations. URM participants identified lab meetings as settings where their self-perception and confidence start to play out. Zara explained: "Lab meetings can be scary and intimidating and yes you are getting feedback and it's constructive." Initially many URM students in this research study were pushed beyond their comfort zones during lab meetings. Cassidy addressed this:

> I think I was not comfortable and confident in what I knew. I remember being scared to talk about the different species for fear of pronouncing the names wrong. The PI would ask me questions about a species, and they knew I knew nothing about. I felt like I literally had no clue.

Some PIs use this strategy to help students build confidence, and, with appropriate support, these approaches can be effective, leading to increased student confidence: "I began to talk a little

more in each research meeting." URM students in this study recognized that level of support and Zara elaborated on this:

> I have heard stories about labs where people are afraid to speak up and give and take criticism, but that is not a thing in my lab. The PI is not harsh regarding their criticism. They are just trying to help you out and you can really tell that. It is a low-pressure environment.

URM students do see their confidence grow in the research setting. When asked about their confidence in conducting research, one participant in this study Carla stated: "I would say I am pretty confident." Dmitry shared: "I have become more confident in myself as a student and a researcher." Cassidy expressed: "I feel like my confidence is improving and has definitely gotten better through this experience." All the URM students in the study reported their confidence growing over time and Alex shared his thoughts:

> In the math setting, it's a little different. If you come in with more experience, whether it be academically or in the research field, you are more than likely going to have a stronger sense of respect from the higher ups where they can let you do whatever and they have a higher expectation of you. I was just kind of mediocre at the things that we were going over. So, it was just kind of hard to fit in. But as we progressed, you know my skills kind of overcame that and for lack of better words I was beyond just lack luster math skills.

Imposter syndrome

Imposter syndrome—a persistent feeling of inadequacy despite evident success—commonly affects URM students and can lead to a reluctance to fully engage in research activities or seek mentorship, as students question their right to belong in academic spaces

(Cokley et al., 2015). Imposter syndrome emerged as a recurring theme in each of the nine interviews conducted. Imposter syndrome was very real for each URM participant. Dmitry stated:

> I am aware that imposter syndrome is a problem and it's something that people face. I think that I've faced it a little bit myself and sometimes I think am I fit to do this?

URM students question their legitimacy as it relates to being in the research space. Stacy explained:

> So sometimes it's kind of like imposter syndrome, just feeling like you don't deserve to be there. Always feeling like there's someone smarter than you.

Most of the students indicated that imposter syndrome occurred early in the research experience, Zoe stated: "I dealt with a bit of imposter syndrome when I first got into it just because it was something completely new to me." Imposter syndrome also emerged when students felt they were expected to have knowledge they had not yet acquired, despite being new to the research process. Zara explained:

> I don't know if I was really comparing myself to anyone in particular, I think I might have just been comparing myself to the idea of what I should be doing and should already know how to do certain things.

Although the intensity and manifestations of imposter syndrome varied, every student reported experiencing it. One URM student's imposter syndrome stemmed from his identity as an Asian male, feeling that the expectations for him were particularly high due to stereotypes associated with his ethnicity. However, his socioeconomic background, lack of experience, and

language barrier initially left him underprepared to navigate the research environment. James explained:

> I did have imposter syndrome. Did I really belong here? I didn't expect to be here. I couldn't confide in people. But when you meet people the first impression is what you look like and who you are visually.

For most URM students in this study, imposter syndrome was replaced by feelings of confidence once they became acclimated to the research environment and Alex addressed these feelings: "Then I got involved in the lab and started to feel a little more like I was a research scientist, I dealt with a little bit of the lack of confidence and imposter syndrome in the beginning." Every participant reported that imposter syndrome began to diminish as they grew in their research experience and Christine added: "The imposter syndrome has gone away and now I am just happy where I am."

For some students in this study gaining the confidence in doing as well as having the support of others helped them overcome feelings of imposter syndrome. Carla explained:

> I'm about to graduate. I'm a scientist. Nobody can delete that. I feel very secure in my position. People believe in you especially if you have imposter syndrome. It's like they look at your accomplishments and things like that and they see your accomplishments and you say maybe I should see that as well.

For some URM students, imposter syndrome may fade over time but can resurface when they face new challenges or encounter unfamiliar experiences like Zara experienced when she was applying to PhD programs:

> Even now with visiting schools and doing interviews I've had a little bit of imposter syndrome where I'm meeting other recruits that have done such amazing work. And I'm like I don't know if the work I've done is good as the person sitting right next to me.

Zara went on to add:

> Imposter syndrome comes from like, very simply comparing yourself. And I think for me, a big part of it relates to the schools that I have not heard back from and thinking about why and then I hear other people at UNC-Chapel Hill have heard from programs that I've been hoping to hear from. So, I think comparing yourself in that regard, where like, these people have this and I don't have this, maybe that makes me less of a good candidate in those pools of recruits. I think it definitely stems from comparison, and particularly things like GPA and other things like extracurricular accomplishments that people might have that you don't necessarily have.

Impostor syndrome, characterized by persistent self-doubt and a fear of being exposed as a "fraud" despite evident success, is known to re-emerge at various life stages, especially during transitions or when confronted with new challenges (Clance & Imes, 1978). Research indicates that individuals may experience a resurgence of impostor syndrome when stepping into roles with increased visibility or responsibility or engaging in a high stakes' opportunity, as these situations often amplify self-perceived inadequacies (Parkman, 2016).

Self-doubt and inadequacy

Experiencing this heightened self-doubt, URM students may internalize the perception that they are "not good enough" or "lacking," despite meeting the rigorous demands of their

fields. This can result in an ongoing sense of needing to "prove" their worth, which in turn detracts from the authentic engagement and intellectual risk-taking essential to thriving in research (McGee & Martin, 2011). For some of the participants, self-doubt was something that occurred at the very beginning of their research journey. Alex explained:

> Doubt for me was kind of like a one- or two-week period where I couldn't find where I fit in, in the research experience itself. I quickly took a step back to analyze why.

Closely related to imposter syndrome are persistent feelings of self-doubt and inadequacy that can undermine students' confidence over time. These feelings can be exacerbated by a lack of role models who share similar backgrounds and experiences or by subtle biases within research settings. Studies show that self-doubt can impact not only students' performance but also their openness to taking on new challenges, asking critical questions, and asserting themselves within research spaces (Syed et al., 2011). Over time, however, positive mentorship, institutional support, and community-building efforts can help URM students develop greater resilience and confidence in their abilities (Hurtado et al., 2011). Most participants managed to address feelings of doubt early on. Dmitry described his strategy: "The best way for someone to address doubt is head on." Having initial doubt seems to be a common pattern for URM students beginning to engage in undergraduate research and their approach to handle this situation and garnering the support of others seems to be an integral part of them navigating away from feelings of self-doubt to feelings of self-efficacy. Alex explained:

> So, this has helped me in the research field. I had to get over things I don't understand, read papers that are way over my head and talk to people that I feel are significantly farther ahead of me in the research base and surround myself with colleagues who are

> stronger researchers. You'll always have doubts whenever it comes to being around people who are in a research field, especially with something like math, there will always be people smarter than me and way more developed than me, but I know I'm capable. So, the best thing I can do instead of doubting my abilities and having that bring me down is go into an experience and really want to get what I can out of these people who are more experienced.

Addressing doubt and feelings of inadequacy requires targeted strategies to foster self-efficacy and affirmation of students' identities as competent researchers. Such interventions help to bolster URM students' self-perception and confidence, enabling them to overcome self-doubt, cultivate resilience, and sustain engagement in their STEM fields. Zara described her transition:

> Looking back and seeing myself transition from needing that support from my graduate student mentors, but then just being able to come into the lab and run things on my own whenever I wanted to, or whenever I was scheduled to come in; that in my head was considered succeeding in undergraduate research.

Theme 3 – Social Dynamics – *Social dynamics refer to the complex interactions and relationships within a group, shaped by factors such as the balance of support and autonomy, the overall inclusivity of the environment, and the nature of cooperative versus competitive engagement.*

Social dynamics refers to the complex interpersonal and group interactions that shape the experiences of the URM participants in this study. These dynamics influence students' sense of belonging, their academic engagement, and their overall success within research environments that may otherwise feel exclusionary or hard to navigate. URM students recognize that certain

research settings are not conducive to social interactions and Carla stated: “I think chemistry tends to be more antisocial, or like most people that have antisocial behaviors.”

The social climate in research settings can affect whether students feel isolated or supported, whether the environment is welcoming or unwelcoming, and whether collaboration is encouraged over competition, all of which have a profound impact on student outcomes (Hurtado et al., 2011; Ong et al., 2011). Students want to learn true research, but most students look for that social camaraderie as well. Zara stated: “Sometimes I go in the lab because I am feeling lonely, and I need to socialize and that becomes a really good motivator for me to go there.” URM participants in this study recognized the importance of building social bonds with their research team and Stacy added: “Outside of the lab social interactions are very important, where you just come together and destress and get to know each other.”

Bringing multiple personalities together and building a positive social dynamic within that research space is something that URM participants feel is important and Zoe explained:

> A major difference and obstacle can be personalities, like I’ve noticed a lot more, like some labs are a lot more social than ours and have a much better camaraderie versus ours is a little more isolated. And I think the PI has realized that and is trying to work on that.

Being a part of a research culture where you are learning is important for URM students, but for some students having a social space within the research space is also important. Christine stated: “The interpersonal and the social and just like the team building, it’s a huge part.” Social dynamics is related to group dynamics in that it addresses issues of independence, isolation, autonomy and how these factors influence the research experience. Zara spoke to this belief:

> Group dynamics of wanting to get everything done is due to kind of the autonomy of our group, and the strengths of our group that we recognized very quickly. And it works, you know, with all our strengths, we all know where we're strong, or weak, we are diverse, we distribute work as such, so we're working together, and our research PI did absolutely nothing to pressure us to do better than anybody else. That type of dynamic where you allow for autonomy and independent leadership on a group level is going to be much better for students who are stronger and more capable in a research setting.

Isolation vs. Independence

One key aspect of social dynamics is the balance between isolation and independence. While independence is often an asset in research, for URM participants, the line between independence and isolation can blur. URM participants recognize the research setting as a place of isolation that requires independence as Cassidy stated: "It's much more isolated, you do a lot more work on your own, it's independent, you set independent goals, it's a lot harder that way to do it if you don't have motivation." For some URM students having to navigate a research environment that calls for independence can take some adjustment as Stacy explained:

> Working with different types of people. Everyone likes to do research differently. Everyone has a different definition of mentor mentee relationship and how involved that can be and to what extent. Like personal connections you can have with people. Everyone is doing their own thing.

When students lack meaningful social or professional connections, they may feel excluded from the collaborative networks critical to research success. Feelings of isolation can also heighten the challenges of navigating complex research tasks without guidance, potentially

stalling their academic progress (Chemers et al., 2011). Conversely, the development of a robust peer or mentor network can foster independence in a positive context, where students feel empowered rather than isolated. Carla spoke to an early chemistry research experience:

> I was given a good base to become independent. I will say that the first chemistry lab that I worked at was good. I learned a lot. I shadowed a bit and then I was doing my own stuff and was given a lot of independence to do things there.

Again, feelings of isolation and independence can really be driven by the mentor and how they handle the relations. Christine explained her current research experience:

> I am happy in the lab I am in now. I've become close with my PI, we're working together, but it's also been very independent.

For URM students, confidence often intersects with the challenges of navigating environments where they may feel isolated or perceive themselves as outsiders due to systemic inequities and underrepresentation in STEM fields (Chemers et al., 2011; McGee & Martin, 2011). Carla experienced feelings of isolation due to her mentor's approach; he did not integrate her into the research team or encourage her independence, instead restricting her to shadowing him for an extended period:

> I was never allowed to touch anything. I was just his shadow. He never introduced me to anybody in the lab. I was never introduced, nobody ever said hi to me.

Many of the students that moved towards independence in a positive way really did embrace the independence associated with undergraduate research. Dmitry explained:

> I think the opportunity to become independent in research has been so rewarding. And it's kind of built a really strong foundation for what I hope to pursue through a PhD program and research in the long term. I've had a chance to build a lot of soft skills as well as present at conferences and presenting for the Team Science class. Even presenting my research in lab meetings and being able to convey whatever we are working on in the lab.

The nature of the research environment—whether it is welcoming or unwelcoming—also influenced the participants' experiences. A welcoming space is typically one where diversity is acknowledged and valued, and where students feel their contributions are respected regardless of background. An unwelcoming environment, however, can deter engagement, as students may experience microaggressions, implicit biases, or overt discrimination, leading them to feel marginalized or unrecognized within their research communities (Cabrera et al., 2014). This unwelcoming atmosphere may discourage students from fully participating or seeking opportunities for growth and support. Alex spoke to feeling unwelcomed in certain spaces early on and attributed it more to the culture of the university instead of the student population:

> Whenever you have somebody's first experience of getting dropped into a classroom of 300 people and you expect to see something, someone who looks like you, and you see nothing, it's very jarring. Everyone treats you okay. I wouldn't say it was on the students' behalf that there's any type of social dissonance, it was more on the university, like my type of expectation for them, rather than these individual people to contribute to what is going on with the system.

While URM participants did not report overtly unwelcoming actions from peers, entering an environment where they lack racial representation can still lead to feelings of isolation (Hurtado et al., 2007). Research shows that environments lacking racial diversity can exacerbate URM students' sense of "otherness," limiting their sense of belonging and comfort (Johnson, 2012). Studies suggest that representation plays a critical role in fostering an inclusive atmosphere, as the presence of similar racial or cultural identities can support URM students' psychological well-being and academic persistence (Strayhorn, 2019). Carla expressed experiencing feelings of unwelcomeness within her initial research environment and how the PI sets the tone:

> I think the PIs should make a place. My PI should have taken it upon himself to make sure that I was part of the team. This is the team, let me introduce you and you have a place. It is not like you need to coddle minorities. But when you come in, you know they will have a harder time fitting in, you need to put in the effort and carve out that little spot. Say, I recognize them as part of the team. I was never invited to lab meetings. They did lunches and activities that I was never invited to.

While many URM students at PWIs do experience an unwelcoming environment in pursuing their educational endeavors in both academic and research spaces a majority of the URM participants reported the research space being a welcoming space as Stacy added: "It has not been a competitive atmosphere, everyone has been welcoming thus far."

Lastly, the balance between collaboration and competition is a crucial social dynamic that affects how URM students perceive their place within the research setting. Highly competitive environments can create stress, intensify feelings of inadequacy, and limit opportunities for collaborative learning, which is vital for skill development and confidence-building in research

contexts (Carter et al., 2020). Stacy who was in a chemistry research lab did indicate that it could feel competitive at times:

> I would say it felt a bit competitive because of just like the atmosphere. Feeling like you need to bring new stuff to the table. I felt the need to be like the best. The PI did set the tone and most of the time it was very collaborative.

Alex indicated that he did not have the competitive mindset:

> I'm not here to compete with you and to be better than you. But I'm here to get through so I can really get to doing what I want to do which is helping other students.

In contrast, a collaborative atmosphere can facilitate peer learning, foster trust, and enhance students' problem-solving skills, thereby supporting the academic and personal growth of URM students (Estrada et al., 2018). Zoe addressed competition and working together in the research setting:

> This weird dynamic, where not everybody is fighting for attention or anything like that. But everybody is trying to work towards proving their individual worth. And it's not necessarily a bad thing in our context. Because there's no competition within the lab, there's no competition to make sure that you're doing better than somebody else, or you're producing these results. We're all working together. We're all supportive of each other and we don't bring each other down.

In sum, being mindful of social dynamics in undergraduate research can help cultivate a more supportive and equitable environment for URM students, promoting not only their academic success but also their confidence and sense of belonging in STEM fields.

Research Question 3 - What programmatic efforts can be identified and implemented to mitigate the challenges and support underrepresented minority (URM) students engaging in undergraduate research?

Programming Support and Initiatives

URM STEM students face unique challenges in navigating academic, research, and professional landscapes. To address these challenges, the support and programmatic support and initiatives described here will cultivate an inclusive and supportive environment through targeted initiatives. The initiatives that were implemented from the research data included a conflict management protocol, diversity training, and a research curriculum. These initiatives are designed to support URM STEM students in conflict management, enhance participants' undergraduate research success, enhance their professional development, and promote a sense of belonging.

The data from this research study highlights the critical significance of the mentoring relationship and the mentor's role. The inquiry partners acknowledged the significant influence of mentoring and the need for mentor centered training. However, the support and programming efforts designed and implemented from the data were specifically tailored to address and be delivered to the URM undergraduate researchers. The rationale for these initiatives centers on supporting and empowering URM undergraduate researchers. Given my direct engagement with these students and limited access to graduate mentors, I identified opportunities to make an immediate impact by proposing and implementing initiatives tailored to URM students and their needs based on the data. Providing targeted support during challenging periods is essential, as such interventions can substantially bolster students' confidence and resilience within the

research environment. Supporting URM STEM students through the challenges inherent in research is crucial for fostering their resilience, persistence, and overall well-being in historically exclusionary fields.

This research study was closely integrated with the T34 grant renewal process. Collaborating with inquiry partners to propose, develop, and implement programmatic efforts based on the study's findings contributed meaningfully to the third grant resubmission. This third and final attempt was successful, resulting in the grant being renewed for an additional five-year period. Furthermore, the NC State T34 program secured funding to support additional trainees, although the exact number of additional trainees had not yet been determined at the time of this study.

Conflict Resolution Protocol

The findings from this study suggest that URM students would benefit from a protocol that clearly outlines the support systems available for conflict resolution. The data, along with incidents involving a significant number of study participants, informed the inquiry team's development of a conflict resolution protocol specifically designed to guide conflict management with the NC State T34 program. These protocols are exclusive to the program and do not supersede formal NC State University policies addressing issues such as grade grievances, academic performance concerns, or discrimination.

Diversity Training that Integrates Conflict Management Style and Cultural Competence Self-Assessment

Diversity training serves as a cornerstone of the program, providing URM STEM students with tools to navigate interpersonal and professional relationships effectively. This training emphasizes conflict management styles, which are critical for mitigating

misunderstandings and fostering collaborative environments (Rahim, 2011). Additionally, sessions on cultural competence equip students to interact effectively across diverse cultural contexts, a skill increasingly valued in global STEM fields (Sue, 2006). These experiences help participants develop self-awareness and empathy, fostering an inclusive mindset that is crucial for their future roles as leaders and collaborators in STEM disciplines.

Advance Together Curriculum

Following collaborative discussions with inquiry partners regarding the data from this study, a research-focused curriculum was designed, developed, and implemented during the fall semester. The *Advance Together* curriculum augments undergraduate research experiences by providing structured opportunities for professional and research skill development. Key components include sessions addressing the graduate school application process, which aim to clarify complex procedures and enhance students' readiness for advanced academic pursuits. Additionally, visits from representatives of diverse universities expose participants to a wide array of PhD programs, expanding their academic perspectives and improving their prospects for successful applications. Title IX training further equips students with knowledge of their rights and responsibilities, fostering safe, inclusive, and equitable academic environments (AAUW, 2021).

Programmatic Initiative 1: Conflict Resolution Protocol

The NC State T34 Conflict Resolution Protocol establishes a structured process for addressing disputes within the training program, focusing on mentor-trainee interactions. The full Conflict Resolution Protocol is presented in Appendix A. Effective conflict resolution protocols should address the unique experiences and challenges faced by URM students. These

protocols should include mechanisms for fostering open communication, providing culturally responsive mediation, and ensuring equitable access to support systems. The T34 grant program manager, which is myself, serves as the primary point of contact (PC) due to my extensive experience in conflict resolution. If conflicts involve program Multiple Principal Investigators (MPIs) or their trainees, the Director of the Comparative Biomedical Sciences (CBS) program will serve as the PC. Mentors who are part of the Comparative Medicine Institute (CMI) Executive Committee are considered to have a conflict of interest and will be excluded from conflict-related discussions and decisions.

The T34 Conflict Resolution Protocol involves conflict resolution steps. The steps include:

1. **Initial Contact and Assessment** where the trainee or mentor contacts the PC, who in turn assesses the conflict's severity to determine if it can be addressed with the T34 program or escalated to university-level procedures.
2. **Information Gathering** where the PC meets with all involved parties to gather details and identify core issues. The PC decides whether conflict resolution efforts are viable or finding an alternate mentor is in the trainee's best interest.
3. **Conflict Resolution Meeting** where if a resolution is pursued, the PC mediates a meeting with all parties to address issues and establish a roadmap for resolution.
4. **MPIs Decision** where the case is presented to the MPIs, who determine one of the following outcomes:
    - Request additional information.
    - Assign a new mentor to the trainee without attributing fault.

- Address mentor-related deficiencies through additional training or removal from the program.
- Address trainee-related deficiencies by assigning a more experienced mentor, probation, or removal if probation goals are unmet.

The T34 Conflict Resolution Protocol was designed to ensure fairness, clarity, and adherence to program and university guidelines while addressing conflicts constructively. The Conflict Protocol Resolution is in the appendix of this research study.

Programmatic Initiative 2: Cultural Competence Self-Assessment and Conflict Management Style Diversity Training

During the summer of 2024 twenty-five students both undergraduates and graduates who were involved in REU, SIRI, and T34 undergraduate research at NC State University participated in a diversity workshop in which they explored their cultural competence and conflict management style. The summer diversity training program brought together well-represented and underrepresented minority (URM) students in STEM fields to promote inclusivity, self-awareness, and effective collaboration in the research settings. Central to the training was the integration of two self-assessment tools: a cultural competence self-assessment (see Appendix B) and a conflict management style inventory (see Appendix C). By exploring their personal scores and engaging in guided discussions, students gained valuable insights into how these traits impact their ability to navigate diverse research environments and collaborate effectively. The guided discussion allowed students to talk about how they manage conflict in the research space and their awareness of cultural differences in the research setting.

Cultural competence self-assessment encouraged students to reflect on their awareness, knowledge, and skills in interacting with people from different cultural backgrounds (Sue, 2006). Cultural competence is a critical skill in today's research and professional environments, where diverse teams are the norm rather than the exception. The assessment served as a springboard for discussions, where students shared their scores and examined how their cultural assumptions and perspectives could influence interpersonal dynamics within their research teams. These conversations highlighted the importance of embracing diverse viewpoints and creating an inclusive atmosphere conducive to innovation and productivity (Spencer-Oatey & Franklin, 2009).

The conflict management style inventory complemented the cultural competence assessment by helping students identify their preferred methods of handling conflict (Rahim, 2011). Conflict, while often unavoidable, can serve as an opportunity for growth and improved collaboration when managed effectively. During the training, students discussed their conflict management styles—such as avoiding, accommodating, competing, collaborating, or compromising—and analyzed how these tendencies could manifest in their research settings. For instance, some students recognized that a competing style might hinder teamwork, while others acknowledged that over-accommodating could lead to personal dissatisfaction and reduced engagement. Through these reflections, students gained a better understanding of how to balance assertiveness and cooperation to foster harmonious research environments.

The training sessions also emphasized the interplay between cultural competence and conflict management. Students explored how cultural differences can shape perceptions of conflict and communication styles, underscoring the need for adaptability and sensitivity. By sharing personal experiences and learning from one another, participants developed practical

strategies for bridging cultural gaps and resolving conflicts constructively. Research has shown that such training not only enhances interpersonal skills but also promotes higher levels of collaboration and trust within diverse teams (Estrada et al., 2016).

Ultimately, the summer diversity training created a space for students to reflect on their individual strengths and areas for growth while fostering a deeper appreciation for diversity and collaboration. By equipping students with the tools to navigate the complexities of undergraduate research settings, the program empowered them to contribute meaningfully to their teams and set the stage for success in future academic and professional endeavors. One student sent a message after training:

> Your diversity workshop on Tuesday was one of the best I've ever attended. I've been a part of numerous diversity/DEI trainings, but I often leave feeling like they fell short. As a transgender, low-income, and autistic student, there are many aspects of my identity that I feel are rarely represented in DEI conversations because people are scared to talk about them. Additionally, I feel like the people who have the most room to benefit from these sessions are often the ones who pay the least attention or are the least involved. Your workshop did a great job in engaging EVERYONE, pointing out that everyone has a unique perspective/identity, and encouraging us all to continue learning more and doing better. I just want you to know that you did a wonderful job and that had a very positive impact on me, so thank you!

Demographic information was collected with the Cultural Competence Self-Assessment and the Conflict Management Style Quiz. Table 4 displays some demographic information

regarding the participants in the diversity training as well as their Cross-Cultural Self-Assessment Awareness, Knowledge, and Skills scores and their Conflict Management Style.

Table 4.1: Diversity Training Cultural Competence and Conflict Management Style Data

Academic Classification	Race	Gender	1st Generation	Awareness Score	Knowledge Score	Skills Score	Conflict Management Style
Undergraduate	Black	Female	No	33	43	36	Collaborating
Undergraduate	White	Female	No	32	36	31	Avoiding Harmonizing
Undergraduate	Black	Female	No	28	40	38	Harmonizing
Undergraduate	White	Female	No	32	36	31	Avoiding Harmonizing
Graduate	Latina	Female	Yes	27	42	34	Harmonizing
Undergraduate	White	Female	No	35	49	37	Collaborating
Undergraduate	Black	Female	Yes	36	36	36	Compromising
Graduate	Asian	Male	No	33	39	No score	Collaborating
Graduate	White	Male	No	29	44	28	Harmonizing
Undergraduate	Asian	Female	No	30	47	41	Avoiding Harmonizing
Undergraduate	White	Female	Yes	37	45	42	Collaborating Avoiding Harmonizing Compromising
Graduate	White	Female	Yes	32	46	40	Competing

Table 4.2: Diversity Training Cultural Competence and Conflict Management Style Data

Academic Classification	Race	Gender	1st Generation	Awareness Score	Knowledge Score	Skills Score	Conflict Management Style
Graduate	White	Female	No	28	31	35	Collaborating
Undergraduate	White	Transman	Yes	37	49	43	Harmonizing
Undergraduate	Asian	Female	No	30	43	35	Avoiding Harmonizing
Undergraduate	White	Female	No	32	36	31	Avoiding Harmonizing
Undergraduate	White	Male	No	30	36	34	Harmonizing
Undergraduate	White	Female	No	38	46	41	Compromising
Undergraduate	Asian	Female	Yes	41	48	44	Collaborating
Undergraduate	White	Female	No	35	46	40	Avoiding
Undergraduate	White	Female	Yes	36	40	42	Avoiding
Undergraduate	White	Male	No	36	44	40	Collaborating
Undergraduate	White	Female	No	33	45	36	Harmonizing
Undergraduate	Multiracial	DNR	No	31	47	35	Collaborating Harmonizing
Undergraduate	White	Transman	No	39	47	35	Avoiding

An analysis of participants Conflict Management Styles revealed no significant or notable factors in the collected data upon initial review. Of the twenty-five students that participated in the diversity training only one participant is shown to have a Competing Style (authoritarian approach) to conflict management, while both graduates and undergraduates represent all other styles which include: Collaborating Style (problems solved in ways in which optimum result is provided for all involved), Avoiding Style (the non-confrontational approach), Harmonizing Style (giving in to maintain relationships) and Compromising Style (the middle ground approach).

A preliminary review of the Awareness, Knowledge, and Skill scores from the Cultural Competence Assessment revealed no significant factors or notable variations within these scores. Cultural competence is a set of congruent beliefs, attitudes, and policies that come together in a system, agency or among professionals and enable that system, agency, or those professions to work effectively in cross-cultural situations (Cross et al., 1989). The main goal of cultural competence self-assessment is to identify areas of strength and areas where an individual can focus on further development to improve their cultural competency. A higher score generally means a greater understanding of cultural differences, positive attitudes towards diversity, and the ability to adapt communication styles to different cultural contexts.

A quantitative approach to analyzing the data collected from the Cultural Competence Self-Assessment and the Conflict Management Style inventory offers potential to uncover deeper insights and correlations between the assessments. Such an analysis could provide valuable statistical evidence regarding patterns, trends, or significant relationships within the data. However, while this methodological approach has merit, it does not align with the primary focus

of Research Question 3, which is exploring programs and initiatives for students. Consequently, a detailed quantitative analysis of this dataset is beyond the scope of this dissertation.

Unfortunately, the diversity training was not formally assessed due to its timing and the lack of prior planning to incorporate assessment into the session. There will be a plan to assess this diversity training model in the future. A future recommendation is to dedicate more time to diversity training (two hours instead of one hour) and continue to use the combination of graduate and undergraduate students' training model, and a formal assessment.

Programmatic Initiative 3: Advance Together Curriculum

The *Advance Together* curriculum (Figure 3) represents the collaborative effort between the T34 grant partners, namely the University Honors Program and the Comparative Medicine Institute, who serve as the inquiry partners for this research study. This curriculum was specifically designed to address the distinctive challenges encountered by URM STEM students as they navigate undergraduate research with historically White academic spaces. Recognizing the intersecting barriers of systemic inequities, social isolation, and underrepresentation, the program provides a structured framework of support to enhance students' academic success, research success, professional development, and sense of belonging. Meeting once a week during the semester through a mix of face-to-face and virtual sessions, the curriculum fosters both practical skill development and community-building opportunities for participants.

A central goal of the *Advance Together* curriculum is to prepare students for the transition from undergraduate research to graduate education. Weekly sessions address critical aspects of the graduate school application process, such as crafting competitive applications, preparing for interviews, and understanding the nuances of graduate admission expectations.

Representatives from various universities are invited to speak with participants about their PhD programs, broadening students' awareness of available opportunities and encouraging them to envision themselves in these spaces. These sessions align with research emphasizing the importance of demystifying graduate education for URM students to improve their access and persistence in advanced STEM degrees (McGee et al., 2017).

To further ensure that students are well-equipped for research excellence, the curriculum includes training on rigor and reproducibility, emphasizing the importance of maintaining high ethical and methodological standards in scientific work (National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). Additionally, Title IX training is incorporated to inform students about their rights and responsibilities, promoting a safe and equitable research environment.

Communication skills are a focal point of the curriculum, with students presenting their undergraduate research as part of their professional development. These presentations provide a platform for participants to refine their ability to articulate complex scientific concepts effectively, a skill critical for both academic and professional success (Lopatto, 2007). By receiving constructive feedback, students gain confidence and improve their public speaking abilities.

Beyond academic and research training, the program includes social activities to foster peer connections and a supportive community. Research indicates that strong peer networks are essential for reducing isolation and enhancing persistence among URM students in STEM (Estrada et al., 2018). In addition to group sessions, participants meet individually with the T34 undergraduate training manager three times per semester for personalized check-ins. These

meetings provide tailored support, helping students navigate challenges and set achievable goals for their academic and professional journeys.

The *Advance Together* curriculum exemplifies a holistic approach to supporting URM STEM students in historically White spaces. By addressing both the academic and social dimensions of their experiences, the program not only prepares students for the next stages of their careers but also contributes to the broader goal of diversifying the STEM pipeline.

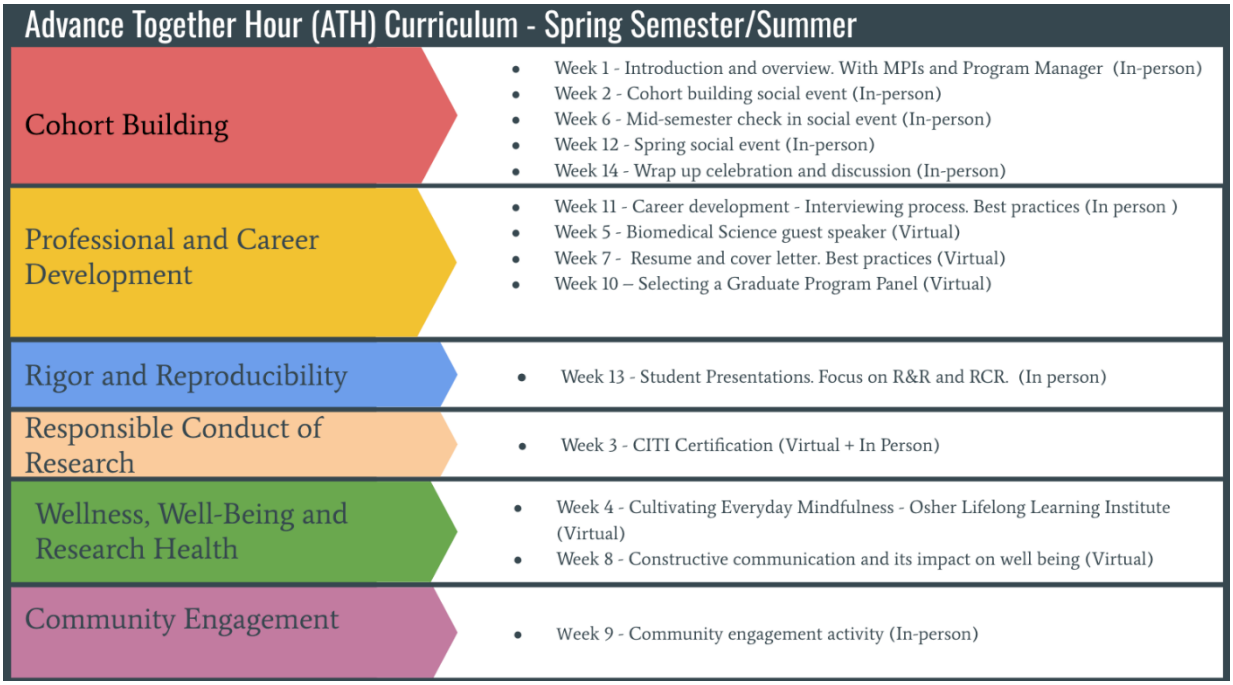
A key component of the curriculum involves students presenting their undergraduate research, which helps refine their communication skills and boosts their confidence in articulating complex ideas (Lopatto, 2007). Such practice is essential for career advancement, as effective communication is a critical competency in STEM professions. Social activities are also integrated into the program to foster peer support networks and a sense of community. Research highlights the importance of such networks in improving persistence and reducing feelings of isolation among URM students (Estrada et al., 2018).

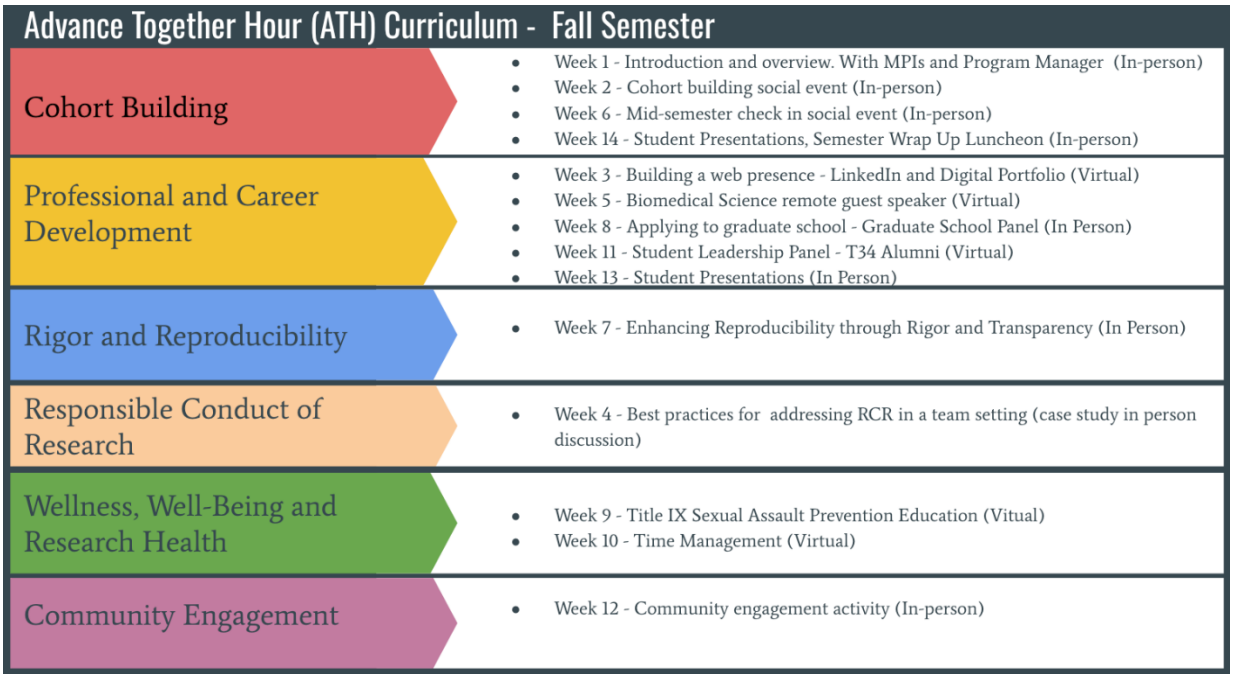
The development and implementation of the *Advance Together* curriculum required extensive planning, collaboration, and refinement to ensure its effectiveness in supporting students' academic and professional growth. The initiative was shaped by input from faculty, program administrators, and student feedback, ensuring that it met the specific needs of URM students in STEM. Significant effort was devoted to structuring a comprehensive curriculum that balanced research skill development with professional preparation, requiring coordination with university partners, industry professionals, and graduate programs to provide meaningful exposure to diverse academic pathways. Additionally, logistical considerations, such as securing funding, organizing guest speakers, and coordinating Title IX training, added layers of

complexity to the initiative's execution. The iterative process of implementation involved continuous assessment and adjustment based on student experiences, ensuring that *Advance Together* remained responsive to participants' evolving needs. By highlighting these behind-the-scenes efforts, it becomes clear that *Advance Together* is not just a set of structured sessions but a carefully designed, multifaceted initiative that required intentional planning and sustained effort to create an impactful experience for students.

By addressing both academic and social dimensions of students' experiences, these programmatic efforts offer an integrated approach to supporting URM students in STEM. The combination of diversity training, tailored curricula, and community-building activities provides a robust framework for fostering personal and professional growth. This model not only empowers participants to succeed but also contributes to a more equitable and diverse STEM workforce. The Fall 2024 *Advance Together* Syllabus is presented in Appendix H.

Figure 3: Advance Together curriculum.





Summary

Chapter 4 presents findings from nine interviews with URM STEM students engaged in undergraduate research through the NIH T34 program within historically White academic spaces. The analysis explored three research questions, uncovering themes and subthemes that offer deeper insights into the lived experiences and perceived barriers faced by URM STEM students in these environments. The themes and subthemes identified in response to the first two research questions informed the development of recommendations addressing the third research question. This chapter outlines suggested programmatic efforts for improvement, grounded in the findings from the responses to research questions one and two.

This chapter includes a demographic overview and personal narratives for each participant, along with a comprehensive breakdown of the coding and thematic analysis. An in-depth exploration of the three guiding research questions is provided, with each theme and subtheme associated with research questions one and two discussed in detail. Additionally, the chapter offers a thorough examination of the programmatic efforts proposed in response to research question three.

Chapter 5 will present an interpretation of the study's findings and connect them to the literature reviewed in Chapter 2. This chapter will also address the study's limitations and explore how the findings and interpretations can inform practices for supporting URM students engaged in undergraduate research within historically White spaces. The chapter will conclude with practical recommendations and final conclusions derived from the research.

CHAPTER 5: SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

The purpose of this qualitative research study was to examine the lived experiences of URM STEM students engaging in undergraduate research in a historically White space. This study explores the experiences of high-achieving URM students in STEM participating in a NIH T34 program at NC State University designed to prepare them for biomedical research PhDs. While the program has had successes, mentoring challenges, imposter syndrome, and social interactions have impacted the URM students in this research study. Instances of toxic research environments and inappropriate mentor behavior underscore the need for improved support systems. Mentoring relationships are critical for fostering research skills, self-efficacy, science identity, and inclusion, yet some aspects of these relationships have failed to meet the program's goals. The persistence of underrepresentation in STEM fields, despite demonstrated interest from URM students, highlights systemic barriers to degree completion, graduate school aspirations, and career advancement.

Discussion

Interpretations of Research Question 1

What are the lived experiences of underrepresented minority (URM) STEM students engaging in research at NC State University, and how do these lived experiences play out in academics, graduate school aspirations, and career choice behaviors? The lived experiences of URM STEM students engaging in undergraduate research at NC State University reveal that identity and representation are critical factors influencing their academic journeys, graduate school aspirations, and career choices. Identity, encompassing facets such as race, gender,

ethnicity, and socioeconomic background, profoundly shape how these students navigate predominantly White and male-dominated fields like STEM. Representation, in turn, pertains to the visibility of individuals from underrepresented groups in these academic and research environments and plays a pivotal role in shaping students' perceptions of belonging and their sense of possibility within STEM fields.

For many students, identity intersects with their academic experiences, influencing their initial decisions to pursue STEM majors and their subsequent paths. One participant highlighted how growing up in Nigeria and witnessing a national shortage of STEM professionals inspired their desire to contribute meaningfully to the field. However, participants also articulated challenges tied to their identities. For instance, they often felt acutely aware of their minority status in academic and research settings, particularly in environments where racial and ethnic diversity was visibly lacking. One student noted the limited presence of Black students in their program, underscoring the broader underrepresentation of racial minorities in STEM research and faculty positions. Similarly, another student reflected on the isolation felt during large lectures, where the lack of diversity was starkly evident.

Representation also inspired many participants to become trailblazers in their fields, motivated by a desire to pave the way for others from similar backgrounds. Students expressed aspirations to counteract the lack of visible role models by achieving success and serving as examples for their communities. For instance, one participant described how their parents' sacrifices inspired them to pursue a meaningful career that would honor their family's journey while making a broader impact. Another student articulated their mindset of overcoming barriers by pursuing opportunities in spaces where people like them were traditionally absent.

Ultimately, the interplay of identity and representation is central to understanding the lived experiences of URM STEM students. A lack of representation can contribute to feelings of isolation and exclusion, while greater representation fosters self-efficacy, mentorship opportunities, science identity, and a supportive environment. These factors are vital to promoting URM students' success in STEM, shaping their academic trajectories, and influencing their aspirations for graduate education and professional careers. This research study underscores the need for systemic and institutional efforts to create more inclusive and equitable spaces within STEM disciplines.

The lived experiences of URM STEM students at NC State University highlight the profound impact of mentorship dynamics on their academic journeys, graduate school aspirations, and career decisions. Mentorship in undergraduate research is shaped by interpersonal and structural factors, influencing how students develop their science identities, research confidence, and professional goals. Participants described positive mentoring experiences as instrumental, citing the encouragement, accessibility, and hands-on support provided by Principal Investigators (PIs) and graduate mentors. Effective mentorship was associated with a collaborative and inclusive research environment where students felt valued and supported in their academic and research growth.

Many students noted how supportive mentors encouraged them to gain deeper knowledge, develop independent research skills, and feel confident in their contributions. Such positive interactions were crucial in shaping their aspirations for graduate school education and careers in STEM fields.

However, not all mentorship experiences were positive. Several female participants shared challenges from toxic mentoring dynamics. This was prominent among female students navigating male-dominated research environments. In some cases, these male mentors displayed sexist or racist behavior, creating hostile environments that led students to seek alternative research placements. One participant recounted being restricted from engaging in hands-on research, which stifled her learning and caused frustration. These negative experiences underscore the potential for mentorship to either empower or hinder students, depending on the mentor's approach and sensitivity to the unique challenges faced by URM students.

Ultimately, mentorship dynamics serve as a critical factor in shaping URM students' experiences in undergraduate research. Positive mentorship fosters skill development, confidence, science self-efficacy, a positive science identity, and a sense of belonging, encouraging students to pursue graduate education. Conversely, toxic mentorship can undermine students' potential and impede their growth, highlighting the need for institutions to prioritize mentorship training and create safeguards to ensure equitable and supportive research environments for all students. The data in this study points to focusing on graduate level mentorship to support URM undergraduate researchers.

The lived experiences of URM STEM students engaging in undergraduate research at NC State University reveal that navigating the research environment is both a challenge and an opportunity for growth. For many URM students, entering predominantly White academic institutions and research settings means adapting to an environment that may not initially reflect their cultural or personal experiences. This adaptation often requires developing social and professional navigation skills to effectively access resources, mentorship, and support systems. These efforts, while challenging, foster resilience and equip URM students with essential skills

for academic and career success. It is important for URM students to recognize the research culture and have the necessary skills to manage challenging situations.

Many URM students reported starting their undergraduate research with limited knowledge about what research entails or how to approach it. This lack of familiarity sometimes created uncertainty, with students describing their initial experiences as daunting and characterized by feelings of inferiority. One student shared how attending early research meetings felt overwhelming, as the technical language and discussions seemed like "a foreign language." Over time, URM participants developed confidence and mastery, transforming these early struggles into opportunities for growth.

The lived experiences brought to light in this research study highlight the critical role of personal growth and resilience in their academic and professional development. URM students often navigate research settings that present unique challenges, from technical skill acquisition to addressing feelings of isolation and imposter syndrome. Their experiences in undergraduate research not only develop their abilities as independent researchers but also foster adaptability, perseverance, and a stronger sense of self-identity as future STEM professionals.

In summary, the lived experiences of URM STEM students engaging in undergraduate research at NC State University underscore the complex interplay of identity, representation, mentorship, and resilience in shaping their academic and professional trajectories. These students navigate challenges that stem from underrepresentation, such as feelings of isolation, implicit biases, and imposter syndrome, while also leveraging supportive mentorship and their own determination to overcome obstacles. Through these experiences, URM students develop critical research skills, build confidence, and clarify their aspirations for graduate school attainment.

Interpretations of Research Question 2

What are the barriers and challenges to achievement for URM STEM students engaging in undergraduate research, and what can be done to address these barriers and challenges?

Barriers to engagement in undergraduate research for URM STEM students at NC State University are multifaceted, stemming from perceived knowledge gaps, gender-based challenges, and systemic inequities. Many URM students begin their research journeys with limited understanding of research norms and expectations, leaving them feeling underprepared and hesitant to engage. Programs like the T34 have been instrumental in addressing these gaps by offering structured entry points, mentorship, and skill-building opportunities, which help URM students gain confidence and recognize the importance of research for their academic and professional advancement.

Gender-based challenges, particularly for URM STEM women, add another layer of complexity. Female participants reported experiences of isolation, bias, and limited mentorship in male-dominated research environments, which compounded feelings of imposter syndrome and hindered engagement. Some female students faced overt prejudice and intimidation, necessitating reassignment to different labs, while others learned to navigate these challenges through self-advocacy and resilience. These gender dynamics also affected male participants, though in different ways, highlighting the need for equitable and inclusive research environments.

Addressing these barriers requires institutional efforts to foster supportive and inclusive research settings through targeted mentorship by trained and culturally competent faculty and graduate level mentors. By mitigating knowledge and gender-related challenges, institutions can

empower URM students to fully engage in undergraduate research, enhancing their academic growth and graduate school aspirations.

Self-perception and confidence are critical factors influencing URM STEM students' engagement in undergraduate research. Initially, many URM students struggle with feelings of inadequacy and self-doubt, compounded by imposter syndrome, which often arises during early research experiences. Students frequently feel intimidated in lab meetings or unprepared for the knowledge expectations, leading to hesitancy in fully participating. These challenges are exacerbated by a lack of representation and role models in research environments.

Through supportive research environments URM students not only build confidence but also develop resilience, learning to navigate and overcome barriers. This journey fosters a stronger sense of belonging in STEM research, enabling students to persist and succeed in their academic and professional trajectories.

Social dynamics play a critical role in shaping the experiences of URM students in STEM undergraduate research environments. The interpersonal and group interactions within these settings can significantly influence students' sense of belonging, academic engagement, and overall success. URM students in this study reported that some research environments, particularly in fields like chemistry, were isolating or lacked social interaction, which made it harder for them to build connections and feel supported. While the desire to engage in research is strong, students also seek social support and camaraderie, which can motivate their participation. Positive social interactions outside the lab, such as team-building activities, were noted as important for fostering a sense of community.

The balance between isolation and independence emerged as a key theme. Research settings often demand a high degree of independence, which can feel isolating for URM students, especially when they lack meaningful connections or guidance. For some, the transition to an independent research environment was challenging, particularly when mentors failed to integrate them into the research community. However, when students were given the autonomy to work independently, it helped them build confidence and develop necessary research skills. Social isolation can also be exacerbated by systemic inequities, making URM students feel like outsiders in environments where they are underrepresented.

Mentorship plays a pivotal role in navigating these social dynamics. Positive relationships with mentors who foster an inclusive, supportive atmosphere can help mitigate feelings of isolation and enhance students' sense of belonging. However, when PIs and graduate mentors neglect to integrate URM students into the research culture, or fail to acknowledge their unique challenges, it can lead to disengagement and hinder students' academic progress.

While many URM participants reported feeling welcomed in their research environments, some also experienced subtle biases or exclusion, particularly in environments lacking racial diversity. The lack of racial representation can contribute to feelings of "otherness," affecting students' confidence and sense of belonging. Furthermore, the competitive nature of some research settings can create stress and undermine collaboration. A highly competitive atmosphere can lead to feelings of inadequacy and hinder peer learning, whereas a collaborative and supportive environment promotes trust, skill development, and mutual growth.

Addressing these social dynamics is essential for creating an environment where URM students can thrive. Fostering a collaborative, inclusive, and supportive research environment

enhances students' academic performance while strengthening their confidence, resilience, and participation in STEM.

URM STEM students at NC State University face a range of barriers to engaging in undergraduate research, including knowledge gaps, gender-based challenges, and systemic inequities. Many students enter research with limited understanding of research norms, leaving them underprepared and hesitant to fully engage in the undergraduate research experience. Gender-based issues, particularly for URM women, include isolation, bias, and lack of mentorship in male-dominated environments, which compound feelings of imposter syndrome. Overcoming these barriers requires institutional efforts to create inclusive research settings, provide mentorship, and train faculty and graduate level mentors in cultural competence.

Interpretations of Research Question 3

What programmatic efforts can be identified and implemented to mitigate the challenges and support underrepresented minority (URM) students engaging in undergraduate research? URM students in STEM face unique challenges, particularly when navigating academic and research landscapes that may not always be inclusive or supportive. To address these challenges, programmatic efforts such as a conflict management protocol, diversity training, and the *Advance Together* curriculum have been proposed, developed, and implemented. These initiatives are designed to provide URM STEM students with the tools they need to be supported and thrive in the research and academic setting while fostering a sense of belonging in the STEM field.

The NC State T34 Conflict Resolution Protocol was developed to promote an inclusive, equitable, and supportive research environment for URM STEM students participating in

undergraduate research. The protocol aims to address and resolve disputes or challenges constructively, ensuring that participants of the T34 program can fully participate in and benefit from STEM research opportunities. The protocol emphasizes promoting mutual respect, understanding, and collaboration, while addressing any barriers – such as discrimination and miscommunication – that might impede the success and well-being of T34 students in research settings.

Diversity training is a foundational element of these efforts, aimed at equipping URM students with the skills to navigate interpersonal and professional relationships in diverse environments. This initial training focused on conflict management styles, helping students develop strategies to manage misunderstandings and foster collaboration. In addition, diversity training emphasized cultural competence, which enables students to engage effectively in cross-cultural interactions—a critical skill in global STEM fields. By encouraging self-awareness and empathy, diversity training contributes to creating a more inclusive mindset, essential for the future leaders and collaborators that URM students are poised to become.

The *Advance Together* curriculum complements students' research experiences by providing structured professional development opportunities. This curriculum offers sessions on the graduate school application process, which demystify complex procedures and to prepare students for successful applications. Additionally, representatives from diverse universities are invited to expose students to a variety of PhD programs, helping them expand their academic horizons. Title IX training is also integrated into the curriculum to ensure students are aware of their rights and responsibilities, promoting safe and equitable academic environments.

A significant component of the curriculum is the opportunity for students to present their undergraduate research. This not only enhances their communication skills but also boosts their confidence in articulating their research. Effective communication is an essential skill in both academic and professional STEM contexts, and by practicing these presentations, students refine their ability to convey their research to a broader audience. The program also incorporates social activities designed to build peer support networks, an important element for eliminating feelings of isolation and increasing persistence among URM students. Research shows that these social networks are vital for maintaining engagement and academic success in STEM (Estrada et al., 2018).

These programmatic efforts address both the academic and social dimensions of students' experiences, offering a comprehensive approach to supporting URM students in STEM. Through a combination of conflict resolution strategies, diversity training, professional development, and community-building activities, the program provides a foundation for student success. This integrated approach not only supports and empowers students to excel in their current research environments but also contributes to the long-term goal of diversifying the STEM workforce.

The diversity training conducted in the summer of 2024 exemplified these efforts. Twenty-five students from various undergraduate and graduate research programs participated in workshops that explored cultural competence and conflict management styles. By using self-assessment tools, students reflected on how their personal attributes and conflict management approaches influence their ability to collaborate in research settings. These discussions helped students understand how cultural differences impact teamwork and conflict, equipping them with strategies to navigate these challenges in future research environments.

In conclusion, the programmatic efforts discussed in this study highlight the importance of a multifaceted approach in supporting URM STEM students engaging in undergraduate research. By combining conflict resolution, diversity training, professional development opportunities, and community-building initiatives, these programs are designed to address the academic, social, and emotional challenges students face. Conflict resolution protocol offers support, diversity training fosters essential skills in cultural competence and conflict management, while the *Advance Together* curriculum provides critical guidance on graduate school preparation, research ethics, and communication skills. These efforts create a supportive environment where students can build confidence, develop leadership skills, and establish valuable peer networks. Together, these initiatives not only empower URM students to succeed in their current academic pursuits but also contribute to diversifying the STEM workforce, ensuring that students are equipped to thrive in an increasingly global and inclusive academic and professional landscape.

Theoretical Framework

The theoretical framework for this study draws on Bandura's Self-Efficacy Theory, which theorizes that an individual's belief in their ability to succeed in specific tasks or environments significantly influences their motivation, resilience, and overall performance (Bandura, 1997). This theory provides a lens to understand how URM STEM students engaging in undergraduate research at a historically White institution navigate challenges and achieve success. Self-efficacy beliefs are shaped by four primary sources: mastery experiences, vicarious experiences, verbal persuasion, and physiological states. Each of these factors is critical in interpreting the findings of this study. Identifying a theoretical framework was a challenging process.

The attempt was made to identify a framework that would allow me some flexibility in engaging in a research study that was organic in nature. The theoretical framework served as a critical lens through which data are collected, analyzed, and interpreted. However, in certain contexts, the adoption of a framework that prioritizes autonomy of the data - allowing it to stand for itself- can be particularly justified. I think Bandura's theory allowed me to do just that. The approach allowed me to minimize bias and allowed the research findings to emerge organically from the data rather than being shaped or constrained by pre-existing theoretical assumptions.

The positive mentorship relationships identified in this research align with Bandura's concept of verbal persuasion, where encouragement and constructive feedback from trusted mentors enhance students' confidence in their abilities. Furthermore, the importance of representation and visibility in the research environment echoes the role of vicarious experiences; seeing role models with similar backgrounds succeed fosters a belief that students can also overcome barriers and excel. Mastery experiences, such as successfully conducting research projects and contributing to STEM fields, further reinforce self-efficacy, enabling students to envision and pursue advanced academic and career pathways.

Conversely, the barriers encountered by participants, including imposter syndrome and the challenges of navigating cultural misalignments, reflect how negative physiological and social experiences can diminish self-efficacy. Addressing these barriers through targeted programs like diversity training and the *Advance Together* curriculum directly supports the development of students' self-efficacy by providing tools to manage stress, build research competencies, and form supportive peer networks. This application of Bandura's Self-Efficacy Theory underscores the importance of fostering environments that empower URM STEM

students to believe in their capabilities and realize their full potential while developing a strong science identity.

Limitations/Delimitations of Research Study

This study examines the lived experiences of URM STEM students engaging in undergraduate research at NC State University has some limitations. While this qualitative approach provided rich, in-depth insights, the perspectives shared may not fully represent the diversity of experiences among URM students at other institutions or within other research contexts.

A delimitation of the study is its focus on a single institution. This context-specific approach provided valuable insights into the dynamics of representation and mentorship at this institution but may limit the applicability of findings to universities with different demographic compositions or institutional cultures. This study also concentrated specifically on STEM fields, excluding URM students in non-STEM disciplines, which might have yielded different patterns of experiences and challenges. The nine participants in this study represent a subset of high-achieving URM students, a population distinct from URM students who may not meet the criteria for high achievement.

Finally, the study's programmatic recommendations, such as diversity training and the *Advance Together* curriculum, were developed based on the identified needs and barriers specific to the study's participants. These solutions may need to be adapted or expanded to address the unique circumstances of other institutions or student populations. Despite these limitations and delimitations, the study contributes meaningful insights into the barriers, resilience, and systemic

needs of URM STEM students, offering actionable steps toward fostering more inclusive undergraduate research environments.

Implications

This study provides valuable insights into the lived experiences of URM STEM students at NC State University, with significant implications for theoretical understanding, institutional practices, and future research. The key findings emphasize the pivotal role of identity, representation, mentorship, resilience, and institutional support in shaping the academic and professional trajectories of URM students in STEM fields. The following implications are derived from the study's results.

Theoretical Implications

The findings of this study contribute to existing literature on the experiences of URM students in higher education, particularly within STEM disciplines, through Bandura's theory of self-efficacy. Bandura emphasizes the role of mastery experiences, vicarious learning, social persuasion, and emotional states in shaping individuals' beliefs in their capacity to succeed. This theoretical framework provides a critical lens for understanding how URM participants in this study navigate the complex interplay between identity, representation, and academic achievement.

A central theme emerging for this study is the interplay between identity and representation, which directly impacts students' self-efficacy. The lack of representation in STEM fields often undermines students' beliefs in their abilities, creating barriers to their sense of belonging and research persistence. Conversely, positive representation and mentorship

experiences serve as a powerful source of vicarious learning and social persuasion, reinforcing students' confidence and graduate education pursuits. These findings challenge traditional models of student engagement in STEM, which frequently neglect the nuanced barriers faced by URM students, particularly those related to race, gender, and socioeconomic background. Future theoretical frameworks must integrate a deeper understanding of how representation – or its absence – shapes students' sense of self-efficacy, belonging, and long-term success in STEM.

Moreover, the study contributes to the literature on mentorship by underscoring its dual nature—both empowering and potentially harmful. Positive mentorship experiences significantly bolster students' confidence and career aspirations, while negative experiences, particularly those related to racism and sexism, create additional barriers for URM students. This highlights the importance of mentorship models that address the specific challenges experienced by URM STEM students. Such models should be structured to promote supportive, inclusive, and collaborative research environments.

Theoretical implications from this study suggest Bandura's self-efficacy theory framework is particularly relevant in advancing scholarship on URM students in STEM. It emphasizes the need for research and practice to focus on interventions that enhance mastery experiences, increase positive representation, and mitigate negative social influences. By doing so, educators, practitioners, and policymakers can support URM students' academic and professional trajectories, contributing to a more equitable and diverse STEM community.

Practical Implications

The findings of this study suggest several practical steps that institutions can take to better support URM students in STEM. The role of representation within academic and research

environments cannot be overstated. Universities and research institutions can prioritize strategic efforts to increase diversity among faculty and research staff while navigating the challenges posed by heightened scrutiny of diversity, equity, and inclusion (DEI) initiatives. To create a more inclusive and supportive environment for URM students in STEM, certain strategies can be employed. The university can institute targeted recruitment and hiring practices by creating partnerships with minority-serving institutions and utilize cluster hiring strategies. Institutions can craft mentorship programs to address the challenges faced by URM students in both the academic and research settings. These types of strategies ensure that institutions are committed to fostering an inclusive research community that create pathways for URM students to achieve academic and research success.

Furthermore, mentorship emerges as a crucial factor in shaping URM students' academic journeys. Investing in formal mentorship programs that match students with faculty and graduate mentors who are committed to fostering inclusive research environments is important. Mentorship programs should incorporate training for mentors to deepen their understanding of the challenges faced by URM students. This training should integrate culturally responsive and equity-centered approaches. Based on the barriers discussed and data that emerged from this research study pairing URM students with diverse mentors who can provide both professional guidance and support. Mentors should be trained on topics like implicit bias, microaggressions, and inclusive leadership that could potentially mitigate toxic mentorship practices. Additionally, the training should equip mentors with strategies to effectively support the growth and success of URM students.

Training graduate-level mentors who work with undergraduate students is essential to fostering effective mentoring relationships that promote academic and personal development.

Research indicates that well-trained mentors are better equipped to provide guidance, foster a sense of belonging, and support students' navigation of academic challenges, particularly for underrepresented populations in STEM fields (Byars-Winston et al., 2015). Such training ensures mentors can address diverse student needs, cultivate inclusive research environments, and positively influence mentees' educational and career trajectories.

The study also highlights the importance of addressing gender-based challenges, particularly for URM women in STEM. Gender dynamics within research labs, including isolation and bias, create additional barriers for these students. To address these challenges, institutions can cultivate research environments that are intentionally gender-inclusive and proactively address and challenge sexist or discriminatory behaviors. This can be achieved through training programs for faculty, graduate level mentors, and researchers, as well as by creating clear reporting mechanisms for instances of bias or harassment.

Social Implications

The findings of this study have significant implications for the social dynamics within STEM research environments. URM students often experience social isolation due to the lack of diversity in their academic and research settings. To address this, institutions could prioritize initiatives that promote social integration and a sense of community among STEM students. Social activities, team-building events, and peer support networks are critical for helping students build relationships and combat feelings of isolation. By fostering a sense of belonging, students are more likely to engage in research and persist in their academic programs.

Additionally, addressing the social isolation felt by URM students requires a concerted effort to create a collaborative and supportive research culture. Faculty and graduate mentors play a crucial role in integrating students into the research community, encouraging teamwork, and creating an environment where all students can succeed. Institutions should therefore invest in programs that support not only academic growth but also social connection, ensuring that URM students are given the opportunities to build lasting relationships and networks within the STEM community.

Conclusion

The lived experiences of URM STEM students at NC State University underscore the profound impact of identity, representation, mentorship, and institutional support on their academic and professional journeys. The implications of this study call for systemic changes within academic institutions to create more inclusive, supportive, and equitable STEM environments. By addressing the barriers faced by URM students and implementing targeted interventions, institutions can foster a more diverse and innovative STEM community, ensuring that all students, regardless of their background, can develop and advance.

Recommendations for Practice

Based on the findings and implications of this study, several recommendations for practice emerge that could enhance the academic and professional experiences of URM students engaging in STEM research at institutions like NC State University. These recommendations focus on creating inclusive and supportive environments, improving mentorship structures, and addressing systemic barriers that hinder URM students' success in STEM fields.

First and foremost, institutions might benefit from prioritizing the recruitment and training of faculty and mentors who possess both strong academic qualifications and cultural competence, ensuring sensitivity to the unique challenges experienced by URM students. Mentorship has proven to be a key factor in the academic and career success of URM students (Estrada et al., 2018). Effective mentorship involves more than just guidance on academic and research tasks; it requires fostering an inclusive, supportive, and empowering environment where URM students feel valued and recognized. These sentiments enable URM students to actively engage the research experience and effectively utilize resources that support their academic and research success. Therefore, universities can enhance mentorship practices by incorporating regular training that emphasizes inclusivity, cultural awareness, and an understanding of the specific challenges encountered by URM students in STEM fields. Moreover, institutions should ensure that students have access to diverse mentors who reflect their racial, gender, and cultural identities, which has been shown to enhance students' sense of belonging and academic persistence (Chang et al., 2014).

Another important recommendation is the development and expansion of programmatic efforts aimed at supporting URM students throughout their academic journeys. Programs like the *Advance Together* curriculum, which provide structured professional development opportunities, have shown to help students gain confidence, improve their communication skills, and better prepare for graduate school and professional careers (Estrada et al., 2018). Such programs should be integrated into the fabric of undergraduate STEM research experiences to help students build the skills necessary for success in research and academia. These programs should include sessions on graduate school applications, research ethics, and career planning, along with workshops that focus on developing skills in conflict resolution, collaboration, and cross-cultural

communication. Furthermore, incorporating Title IX training into these programs is essential to ensure students are aware of their rights and responsibilities, particularly regarding issues of discrimination, harassment, and inequity in STEM environments.

Additionally, it is essential for institutions to address social and cultural dynamics within research environments to reduce feelings of isolation and increase a sense of belonging among URM students. Social dynamics, such as exclusionary group interactions or lack of peer support, often contribute to disengagement and impede academic success. Providing students with opportunities for team-building activities, peer networks, and social support outside of the research setting can counteract isolation and foster a sense of community (Estrada et al., 2018). Encouraging collaborative research environments where students work together and share experiences can further reduce feelings of alienation and help students feel more connected to their academic and professional pursuits. Research has shown that creating these types of social support networks is critical for student persistence in STEM fields (Baker, 2013). Therefore, institutions should invest in creating structured opportunities for peer support, such as research retreats, group study sessions, or social events that bring students from diverse backgrounds together.

Furthermore, institutions might consider taking proactive steps to address the systemic inequities that underrepresented students face in STEM fields. This includes reviewing and revising policies that might inadvertently perpetuate barriers to engagement and success. For example, addressing gender-based disparities and promoting gender equity in STEM research labs is crucial for ensuring that all students, regardless of their gender, feel safe and supported in their academic environments. Gender-based challenges, particularly for URM women, have been shown to contribute to feelings of isolation and imposter syndrome (Gibson, 2015). Therefore,

institutions are encouraged to foster more inclusive research environments by promoting gender equity, supporting female students in male-dominated spaces, and providing mentorship and networking opportunities for women in STEM.

Moreover, creating a pipeline for students to enter research environments with adequate preparation is essential. As this study and previous research has revealed, many URM students enter STEM research with limited knowledge of research norms and expectations, which often leaves them feeling unprepared and hesitant to engage (Graham et al., 2013). Offering preparatory programs that introduce students to research methods, techniques, and academic expectations can help build confidence and reduce feelings of inferiority when students first enter research settings. These programs should be designed to provide early exposure to research, offer hands-on learning experiences, and connect students with mentors who can guide them through the initial stages of their academic research journey.

Lastly, institutions can actively promote and integrate diversity in STEM faculty recruitment. Increasing the representation of URM faculty and researchers is essential for creating a more inclusive and supportive academic environment. Research has shown that representation matters for students, not only in terms of feeling seen but also in the mentorship and opportunities available to them (Brown & Davis, 2001). By diversifying the faculty, institutions can provide more role models for URM students, increasing their likelihood of success and persistence in STEM fields.

In conclusion, these recommendations emphasize the need for comprehensive and sustained efforts to address the academic, social, and institutional challenges faced by URM students in STEM. By implementing strategies that focus on mentorship, professional

development, community-building, and institutional reform, universities can better support URM students and empower them to thrive in STEM research. These efforts will not only enhance the success and well-being of individual students but also contribute to diversifying the STEM workforce and ensuring that it reflects the full range of talent and perspectives necessary for addressing the complex challenges of the future.

Recommendations for Future Research

The findings of this study open several avenues for future research. First, further studies should explore how URM students' experiences in STEM research environments compare across different institutions, disciplines, and geographic regions. Such studies could provide a more comprehensive understanding of the factors that contribute to the success or challenges faced by URM students in different contexts.

Future research could examine the long-term career outcomes of URM STEM students who have engaged in undergraduate research. While this study sheds light on the immediate challenges and barriers to success, there is a need for longitudinal studies that track students' academic trajectories and career choices over time. Understanding how undergraduate research experiences influence career outcomes, including graduate school enrollment and professional advancement, could inform strategies to better support URM students in their long-term academic and professional development.

Additionally, future research could focus on evaluating the effectiveness of programmatic efforts like diversity training, mentorship programs, and research development curricula. Longitudinal evaluations of these programs can provide insights into best practices for creating

inclusive research environments and supporting URM students in their academic and professional growth.

Although much of the current research highlights the immediate academic and professional gains of these experiences, there is a gap in understanding how these early interventions influence students' trajectories over time (Graham et al., 2013). Longitudinal data could provide deeper insights into the sustained effects of mentorship, representation, and identity on students' decisions to pursue advanced degrees or enter STEM careers.

Second, research exploring the intersectionality of race, gender, and socioeconomic status within the context of STEM research environments would provide a more nuanced understanding of how these multiple identities shape students' experiences. Previous studies have emphasized the importance of mentorship and representation, but more work is needed to understand how compounded challenges—such as those experienced by URM women in male-dominated research labs—affect academic engagement and career decisions (Brown & Davis, 2001). A focus on intersectional experiences can inform targeted interventions that address the unique barriers faced by students with overlapping marginalized identities.

In addition, exploring the role of social dynamics within research settings is crucial for understanding how the culture of research environments influences the experiences of URM students. While the current research highlights the isolation and lack of social integration that many URM students experience, further studies are needed to investigate the specific mechanisms that contribute to these feelings and the strategies that students use to overcome them (Estrada et al., 2018). Future research could focus on developing and testing interventions designed to foster community and belonging in STEM research spaces, perhaps through peer

mentorship programs or enhanced team-building activities that encourage collaboration among diverse student groups.

Future research should continue to explore the complex factors that influence URM students' academic and professional trajectories in STEM, with a particular focus on longitudinal outcomes, intersectional identities, social dynamics, and institutional practices. Such research will be essential for developing evidence-based interventions that promote the success and persistence of URM students, ultimately contributing to a more diverse and inclusive STEM workforce.

Lastly, as a result of using ChatGPT further research could explore the methodological implications of using ChatGPT and other AI technologies as supplements to manual coding in qualitative research. Given the increasing interest in AI-assisted data analysis exploring in further could provide valuable guidance for scholars considering this approach. Best practices for integrating AI tools into coding workflows, addressing issues of reliability, transparency, and researcher oversight can be further explored. Further investigation into the use of AI technology could offer recommendations on how to critically evaluate AI-generated codes, ensuring alignment with theoretical frameworks and research objectives. By systematically assessing the benefits and limitations of AI-assisted coding, future research can contribute to the development of rigorous and ethical guidelines for leveraging AI in qualitative analysis.

Growth as a Scholarly Practitioner

Completing this research study on the lived experiences of URM STEM students engaging in undergraduate research within a historically White space has been an intellectually transformative and deeply personal journey. This research not only allowed me to amplify the

voices of URM STEM students but also facilitated my own growth as a scholarly practitioner, shaping my understanding of equity, advocacy, and the complexities of systemic change in higher education.

Through the process of conducting this research, I have come to recognize the profound impact that my positionality has on my approach to scholarship and practice. Engaging with the narratives of URM STEM students revealed the extent to which identity, power, and privilege influence educational experiences, as well as my own role within these dynamics. I have developed a heightened awareness of the responsibility I hold as practitioner to challenge exclusionary practices and foster environments that prioritize inclusion, representation, and belonging.

The dissertation process sharpened my analytical and critical thinking skills, teaching me to navigate the intersection of theory, data, and practice with greater precision. Engaging with Bandura's theory of self-efficacy, for example, allowed me to see how theoretical frameworks can illuminate pathways for supporting students while simultaneously identifying gaps in existing institutional practices. This has enhanced my ability to bridge the gap between research and practice, ensuring that my work not only contributes to academic discourse but also drives meaningful institutional transformation.

Perhaps most importantly, I have learned about the resilience and strength required to persist in addressing systemic inequities. Conducting this research in a context where DEI efforts are increasingly under attack challenged me to think strategically about how to advocate for change within constrained environments. I have grown in my capacity to navigate resistance with a focus on collaboration, evidence-based advocacy, and persistence.

In sum, completing this dissertation has solidified my identity as a scholarly practitioner who is deeply committed to equity and justice in STEM education. I have developed the skills and insights necessary to critically analyze institutional practices, advocate for underrepresented voices, and design interventions that address systemic inequities. This process has not only prepared me to contribute to the scholarly community but also empowered me to lead with intentionality, courage, and a steadfast commitment to fostering inclusive and transformative educational spaces.

Summary and Conclusions

This study has explored the lived experiences of nine URM STEM students engaging in undergraduate research at NC State University, a historically White institution. Through in-depth qualitative analysis, the findings reveal a nuanced interplay of identity, representation, mentorship dynamics, and personal growth in shaping students' academic trajectories, graduate school aspirations, and career choices. Participants highlighted how visibility and representation in research environments impacted their electing to entering STEM studies and a sense of belonging. The results of this study indicate positive mentorship relationships played a pivotal role in building confidence, science self-efficacy, and professional development. At the same time, students exhibited resilience as they navigated complex social and institutional landscapes, demonstrating their agency in overcoming challenges.

The barriers to engagement for URM students, as revealed in the study, encompassed issues of self-perception, confidence, and the challenges posed by navigating social dynamics in historically White research spaces. Many participants reported struggling with imposter syndrome and a lack of access to equitable opportunities, further compounded by cultural

misalignments within their research environments. Addressing these barriers requires a multi-faceted approach that includes fostering supportive communities, improving access to mentorship opportunities, and promoting self-advocacy skills. Participants emphasized the critical need for systemic changes to mitigate these challenges and create pathways to success for URM students in STEM.

In response to these findings, this study proposed actionable programmatic efforts that are designed to support URM students in undergraduate research. The development of a protocol designed to support URM STEM students who may experience conflict in the research setting is a process that will help URM students and mentors navigate and understand the challenges and dynamics that contribute to conflicts. The development of a targeted diversity training program focused on conflict management and cross-cultural competence addresses key challenges related to social dynamics and inclusivity. Additionally, the *Advance Together* curriculum aims to provide comprehensive support through graduate school application guidance, research best practices, and social bonding opportunities. By implementing these initiatives, institutions can not only support the academic and professional development of URM STEM students but also foster a more inclusive and equitable research culture that empowers all students to thrive

REFERENCES

Admissions fast facts. Undergraduate Admissions. (n.d.). https://admissions.ncsu.edu/apply/fast-facts/

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, *36*(3), 269-287.

Allen, B. J., & Garg, K. (2016). Diversity matters in academic radiology: acknowledging and addressing unconscious bias. *Journal of the American College of Radiology*, *13*(12), 1,426-1,432.

Almousa, N. A., Al-Shobaki, N., Arabiyat, R., Al-Shatrat, W., Al-Shogran, R., & Sulaiman, B. A. (2022). Academic problems facing high achieving students at universities. *Pegem Journal of Education and Instruction*, *12*(4), 12-19.

Alvarez, A. N., Blume, A. W., Cervantes, J. M., & Thomas, L. R. (2009). Tapping the wisdom tradition: Essential elements to mentoring students of color. *Professional Psychology: Research and Practice, 40*(2), 181–188.

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *47*(5), 564-582.

American Association of University Women (AAUW). (2021). *Know your rights: Title IX and sexual harassment.*

Atkins, K., Dougan, B. M., Dromgold-Sermen, M. S., Potter, H., Sathy, V., & Panter, A. T. (2020). "Looking at myself in the future": How mentoring shapes scientific identity for STEM students from underrepresented groups. *International Journal of STEM Education*, *7*, 1-15.

Baker, R. D. (2013). How to foster student success in STEM fields: Understanding the social dynamics of underrepresented minorities in science, technology, engineering, and mathematics. *Journal of Higher Education Research*, 18(4), 45-58.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. Flavell and L. Ross (Eds.), *Social cognitive development: Frontiers and possible futures* (pp. 200 –239). Cambridge, England: Cambridge University Press.

Bandura, A. (1977). Self-efficacy: Towards a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117-148.

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

Barongan, T., Neikirk, K., Shao, B., Vue, N., Spencer, E. C., Kabugi, K., ... & Hinton, A. (2023). Project Strengthen: A STEMM-focused career development workshop to prepare underrepresented minority students for graduate school. *Iscience*, *26*(10).

Bangera, G., & Brownell, S. E. (2014). Course-based undergraduate research experiences can make scientific research more inclusive. *CBE—Life Sciences Education, 13*(4), 602-610.

Beckman, M., & Hensel, N. (2009). Making explicit the implicit: Defining undergraduate research. *CUR Quarterly*, *29*(4), 40-44.

Bernard, H. R. (2017). *Research methods in anthropology: Qualitative and quantitative approaches*. Rowman & Littlefield.

Betz, A. R., King, B., Grauer, B., Montelone, B., Wiley, Z., & Thurston, L. (2021, July). Improving academic self-concept and stem identity through a research immersion: Pathways to STEM summer program. *Frontiers in Education, 6*, 674,817). Frontiers Media SA.

Bhattacharyya, P., & Chan, C. W. (2021). Can undergraduate research participation reduce the equity gap?, *Journal of the Scholarship of Teaching and Learning*, *21*(1).

Blanton, R. L., Taraban, R., & Blanton, R. (2008). A brief history of undergraduate research, with consideration of its alternative futures. *Creating effective undergraduate research programs in science: The transformation from student to scientist* (pp. 233-246).

Birks, M., Chapman, Y., & Francis, K. (2023). *Qualitative research: A practical guide for research students*. SAGE Publications.

Bodenhausen, G. V., & Richeson, J. A. (2010). Prejudice, stereotyping, and discrimination. *Advanced Social Psychology The State of Silence*, 341-383.

Boncana, M., McKayle, C. A., Engerman, K., & Askew, K. (2021). " What is going on here?" Exploring Why HBCU Presidents are Successful in Producing STEM Graduates. *Journal of Negro Education, 90*(3), 277-287.

Boulton, C. (2016). Black identities inside advertising: Race inequality, code switching, and stereotype threat. *Howard Journal of Communications*, *27*(2), 130-144.

Braun, V., & Clarke, V. (2006). *Using thematic analysis in psychology.* Qualitative Research in Psychology, 3(2), 77-101

Bravata, D. M., Watts, S. A., Keefer, A. L., Madhusudhan, D. K., Taylor, K. T., Clark, D. M., Nelson, R. S., Cokley, K. O., & Hagg, H. K. (2020, April). Prevalence, predictors, and treatment of impostor syndrome: A systematic review. *J Gen Intern Med, 35*(4), 1,252-1,275.

BrckaLorenz, A., Haeger, H., & Priddie, C. (2021). An examination of inclusivity and support for diversity in STEM fields. *Journal for STEM Education Research*, *4*(3), 363-379.

Brickhouse, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching*, *38*(3), 282-295.

Brickhouse, N., Lowery, P., & Schultz, K. (2000). What kind of girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458.

Brickhouse, N. W., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *38*(8), 965-980.

Briggs, C. (2017). The policy of STEM diversity: Diversifying STEM programs in higher education. *Journal of STEM Education*, *17*(4).

Brisbane, J. M. (2024). Leveraging Epistemic Exclusion as a Lens for Investigating Black Engineering Students' Undergraduate Research Experiences.

Brown, M. C., & Davis, M. S. (2001). A framework for improving the success of underrepresented students in STEM disciplines. *The Journal of Higher Education*, 72(6), 676-694. https://doi.org/10.1080/00221546.2001.11780698.

Bruthers, C. B., Hedman, E. L., & Matyas, M. L. (2021). Undergraduate research programs build skills for diverse students. *Advances in Physiology Education, 45*(2), 399-408.

Byars-Winston, A., Estrada, Y., Howard, C., Davis, D., & Zalapa, J. (2015). 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.

Byars-Winston, A., & Rogers, J. G. (2019). Testing intersectionality of race/ethnicity × gender in a social–cognitive career theory model with science identity. *Journal of Counseling Psychology, 66*(1), 30–44.

Burton, G. S., & Vicente, M. D. G. H. (2021). A narrative analysis examining influential factors of a minority research and training program. *Journal of College Student Retention: Research, Theory & Practice*, *23*(2), 187-213.

Burton, G. S., & Maria da Graça, H. V. (2020). An examination of factors deterring the pursuit of advanced degrees among alumni of a minority research and training program. *Ethnicity & Disease*, *30*(2), 313.

Cabrera, N. L., Milem, J. F., Jaquette, O., & Marx, R. W. (2014). A critical race analysis of the inclusion of diversity and equity in higher education. *Review of Higher Education, 37*(1), 25-52

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *44*(8), 1,187-1,218.

Carpi, A., Ronan, D. M., Falconer, H. M., & Lents, N. H. (2017). Cultivating minority scientists: Undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM. *Journal of Research in Science Teaching, 54*(2), 169-194. https://doi.org/10.1002/tea.21341.

Carter, F. D., Mandell, M., & Maton, K. I. (2020). The influence of on-campus, academic year undergraduate research on STEM PhD outcomes: Evidence from the Meyerhoff Scholars Program. *Educational Evaluation and Policy Analysis, 42*(2), 167-188.

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. *The Review of Higher Education, 31*(4), 433-464. https://doi.org/10.1353/rhe.0.0011.

Chang, M. J., Eagan, M. K., Lin, M. H., & Hurtado, S. (2014). Considering the impact of racial stigmas and science identity: Persistence among biomedical and behavioral science aspirants. *Journal of Higher Education, 82*(5), 646–67

Chang, M. J., Eagan, M. K., Lin, M. H., & Hurtado, S. (2014). Cultural congruity and the success of underrepresented students in STEM fields. *Research in Higher Education*, 55(2), 149-171. https://doi.org/10.1007/s11162-013-9311-6.

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. *Journal of Research in Science Teaching, 51*(5), 555-580. https://doi.org/10.1002/tea.21146.

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67*(3), 469-491.

Clance, P. R., & Imes, S. A. (1978). The imposter phenomenon in high achieving women: Dynamics and therapeutic intervention. *Psychotherapy: Theory, Research & Practice*, *15*(3), 241.

Clark-Blickenstaff, J. (2005). Women and science careers: Leaky pipeline or gender filter?. *Gender and Education*, *17*(4), 369-386.

Cohen, J. J., Gabriel, B. A., & Terrell, C. (2002). The case for diversity in the health care workforce. *Health Affairs*, *21*(5), 90-102.

Cokley, K., McClain, S., Enciso, A., & Martinez, M. (2013). An examination of the impact of minority status stress and imposter feelings on the mental health of diverse ethnic minority college students. *Journal of Multicultural Counseling and Development, 41*(2), 82-95.

Cole, D., & Espinoza, A. (2008). Examining the academic success of Latino students in science technology engineering and mathematics (STEM) majors. *Journal of College Student Development*, *49*(4), 285-300.

Collier, K. M., & Blanchard, M. R. (2023). Toward a holistic understanding of factors that support or inhibit graduate student success. *Trends in Higher Education*, *2*(3), 389-408.

Conte, M. L., & Omary, M. B. (2018). NIH Career Development Awards: Conversion to research grants and regional distribution. *The Journal of Clinical Investigation*, *128*(12), 5,187-5,190.

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

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE Publications, Inc.

Creswell, J. W., & Plano Clark, V. L. (2011). Designing and conducting mixed methods Research.

Crocker, J., Major, B., & Steele, C. M. (1998). Social stigma. In D. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *Handbook of social psychology* (4th ed.), *2*, 504–553. New York: McGraw-Hill.

Cross, T., Bazron, B., Dennis, K., & Isaacs, M., (1989). *Towards A Culturally Competent System of Care, Volume I.* Washington, DC: Georgetown University Child Development Center, CASSP Technical Assistance Center.

Davis, S. M. (2018). Taking back the power: An analysis of Black women's communicative resistance. *Review of Communication*, *18*(4), 301-318.

Denzin, N. K., & Lincoln, Y. S. (2000). *Handbook of qualitative research.* Sage.

Denzin, N., & Lincoln, Y. (2000). Introduction: The discipline and practice of qualitative research. In N. Denzin and Y. Lincoln (Eds.), *Handbook of qualitative research,* pp. 1-28. Thousand Oaks, CA: Sage.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology*, *56*(1), 5.

De Welde, K., & Laursen, S. (2011). The glass obstacle course: Informal and formal barriers for women Ph. D. students in STEM fields. *International Journal of Gender, Science and Technology*, *3*(3), 571-595.

Dortch, D., & Patel, C. (2017). Black undergraduate women and their sense of belonging in STEM at predominantly White institutions. *NASPA Journal About Women in Higher Education*, *10*(2), 202-215.

Dou, R., Cian, H., & Espinosa-Suarez, V. (2021). Undergraduate STEM Majors on and off the Pre-Med/Health Track: A STEM Identity Perspective. *CBE-Life Sciences Education, 20*(2). https://www.lifescied.org/doi/full/10.1187/cbe.20-12-0281

Dovidio, J. F., Gaertner, S. E., Kawakami, K., & Hodson, G. (2002). Why can't we just get along? Interpersonal biases and interracial distrust. *Cultural Diversity and Ethnic Minority Psychology*, *8*(2), 88.

Dugan, J. P., & Komives, S. R. (2010). *Leveraging leadership: Using social change model to enhance undergraduate student leadership development.* Journal of Leadership Education, 9(1), 1-24.

Dunn, A. (2019, June 19). *The personal side of speech and expression*. Pew Research Center - U.S. Politics & Policy. https://www.pewresearch.org/politics/2019/06/19/the-personal-side-of-speech-and-expression/

Eagan, M. K., Jr., Hurtado, S., Chang, M. J., Garcia, G. A., Herrera, F. A., & Garibay, J. C. (2013, August). Making a difference in science education: The impact of undergraduate research programs. *American Education Research Journal, 50*(4), 683-713. doi:10.3102/0002831213482038. PMID: 25190821; PMCID: PMC4152010

Eakins, A., & Eakins Sr, S. L. (2017). African American students at predominantly White

institutions: A collaborative style cohort recruitment & retention model. *Journal of Learning in Higher Education, 13*(2), 51-57.

Elmesky, R., & Seiler, G. (2007). Movement expressiveness, solidarity and the (re) shaping of African American students' scientific identities. *Cultural Studies of Science Education*, *2*, 73-103.

Engle, J., & Tinto, V. (2008). Moving beyond access: College success for low-income, first-generation students. *Pell Institute for the Study of Opportunity in Higher Education*.

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), 209-241.

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutierrez, C. G., Hurtado, S., John, G. H., Matsui, J., McGee, R., Okpodu, T., Robinson, J., Summers, M. F., Werner-Washburne, M., & Zavala, M. (2017). Improving underrepresented minority student persistence in STEM. *CBE-Life Sciences Education, 15*(3). https://doi.org/10.1187/cbe.16-01-0038

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., & Zavala, M. (2016). Improving underrepresented minority student persistence in STEM. *CBE—Life Sciences Education, 15*(3).

Estrada, M., Hernandez, P. R., & Schultz, P. W. (2018). A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE—Life Sciences Education, 17*(1), ar9.

Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2018). Toward a model of social influence that explains minority student involvement in STEM. *Journal of Educational Psychology*, 110(3), 368-380. https://doi.org/10.1037/edu0000230.

Estrada, M., Hernandez, P. R., & Schultz, P. W. (2011). Improving underrepresented minority student persistence in STEM. *CBE—Life Sciences Education, 10*(3), 283–290.

Evans, R. M., Johnson, J. A., Garman, A. N., & Kletke, P. (2013). Meeting the challenge: Career development and targeted enrichment programs insuring a viable pipeline. *SAGE Open*, *3*(2).

Ewing, K. M., Richardson, T. Q., James-Myers, L., & Russell, R. K. (1996). The relationship between racial identity attitudes, worldview, and African American graduate students' experience of the imposter phenomenon. *Journal of Black Psychology*, *22*(1), 53-66.

Fernández, C. R., Silva, D., Mancias, P., Roldan, E. O., & Sánchez, J. P. (2021). Hispanic identity and its inclusion in the race discrimination discourse in the United States. *Academic Medicine*, *96*(6), 788-791.

Fiarman, S. E. (2016). Unconscious bias: When good intentions aren't enough. *Educational Leadership, 74,* 10-15.

Figueroa, T., & Hurtado, S. (2013). *Underrepresented racial and/or ethnic minority (URM) graduate students in STEM disciplines: A critical approach to understanding graduate school experiences and obstacles to degree progression*. Los Angeles, CA: Association for the Study of Higher Education/University of California, Los Angeles.

Finley, A., & McNair, T. (2013). *Assessing underserved students' engagement in high impact practices*. Washington, DC: Association of American Colleges and Universities.

Flowers III, A. M., & Banda, R. (2016). Cultivating science identity through sources of self-efficacy. *Journal for Multicultural Education, 10*(3), 405-417.

Garcia, P., & Scott, K. (2016). Traversing a political pipeline: An intersectional and social constructionist approach toward technology education for girls of color. *InterActions: UCLA Journal of Education and Information Studies*, *12*(2).

Garrison, H. (2013). Underrepresentation by race–ethnicity across stages of U.S. science and engineering education. *CBE—Life Sciences Education*, *12*(3), 357-363.

Garvey, J. C. (2018). Possibilities and challenges of critical research in student affairs. *Journal of Diversity in Higher Education*, *11*(1), 20-29.

Gazley, J. L., Remich, R., Naffziger-Hirsch, M. E., Keller, J., Campbell, P. B., & McGee, R. (2014). Beyond preparation: Identity, cultural capital, and readiness for graduate school in the biomedical sciences. *Journal of Research in Science Teaching*, *51*(8), 1,021-1,048.

Gibau, G. S. (2015, Fall). Considering student voices: Examining the experiences of underrepresented students in intervention programs. *CBE Life Sci Educ., 14*(3). doi:10.1187/cbe.14-06-0103. PMID: 26163562; PMCID: PMC4710386.

Gibau, G. S., Foertsch, J., Blum, J., Brutkiewicz, R., Queener, S., Roman, A., Rhodes, S., Sturek, M., Wilkes, D., & Broxmeyer, H. (2010). Diversifying biomedical training: A synergistic intervention. *J Women Minor Sci Eng, 16*, 215–235.

Gibbs, K. D., Jr. (2014). Diversity in STEM: What it is and why it matters. *Scientific American*.

Gibbs, K. D., & Griffin, K. A. (2013). What do I want to be with my Ph.D.? The roles of personal values and structural dynamics in shaping the career interests of recent biomedical science Ph.D. graduates. *CBE—Life Sciences Education*, *12*(4), 711-723.

Gibson, C. (2015). Gender and STEM: Understanding the barriers to success for women in science and engineering. *Journal of STEM Education*, 16(3), 34-45.

Gildehaus, L., Cotter, P., Buck, S., Sousa, M., Hueffer, K., & Reynolds, A. (2019). The research, advising, and mentoring professional: A unique approach to supporting underrepresented students in biomedical research. *Innovative Higher Education*, *44*, 119-131.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for Qualitative research.* Aldine, Chicago.

Goodman, D. (2020). Cultural competence for equity and inclusion. *Understanding and Dismantling Privilege, 10*(1), 41-60. https://www.wpcjournal.com/article/view/20246.

Goodman, K. M., & Bowman, N. A. (2014). Making diversity work to improve college student learning. *New Directions for Student Services*, *2014*(147), 37-48.

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science*, *341*(6153), 1,455-1,456.

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *The Journal of Higher Education*, *69*(6), 589-620.

Guest, G. (2023). The role of artificial intelligence in qualitative research. *Qualitative Research Methods Journal, 45*(2), 17-29.

Guest, G., Namey, E., Taylor, J., Eley, N., & McKenna, K. (2022). Basic concepts of qualitative research: Planning and analysis techniques for saturation and sample size in qualitative studies. Field Methods, 34(4), 321-334.

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.

Gurin, P., Dey, E. L., Gurin, G., & Hurtado, S. (2004). The educational value of diversity. *Defending diversity: Affirmative action at the University of Michigan,* 97-188.

Gurin, P., Dey, E., Hurtado, S., & Gurin, G. (2002). Diversity and higher education: Theory and impact on educational outcomes. *Harvard Educational Review*, *72*(3), 330-367.

Gurin, P., Nagda, B. R. A., & Lopez, G. E. (2004). The benefits of diversity in education for democratic citizenship. *Journal of Social Issues*, *60*(1), 17-34.

Haeger, H., & Fresquez, C. (2016). Mentoring for inclusion: The impact of mentoring on undergraduate researchers in the sciences. *CBE—Life Sciences Education, 15*(3).

Hale, F. W. (Ed.). (2023). *What makes racial diversity work in higher education: Academic leaders present successful policies and strategies*. Taylor & Francis.

Hall, J. C., Everett, J. E., & Hamilton-Mason, J. (2012). Black women talk about workplace stress and how they cope. *Journal of Black Studies*, *43*(2), 207-226.

Hall, A. K., Miklos, A., Oh, A., & Gaillard, S. D. (2016). *Educational outcomes from the maximizing access to research careers undergraduate student training in academic research (MARC U-STAR) program.*

Harper, S. R. (2012). *Serving underserved populations: A review of empirical research on underrepresented students in higher education.* National Review of Educational Policy and Practice, 1(3), 2-18.

Harris, T. M., & Lee, C. N. (2019). Advocate-mentoring: A communicative response to diversity in higher education. *Communication Education*, *68*(1), 103-113.

Harvey, J. C., & Katz, C. (1985). *If I'm so successful, why do I feel like a fake? The imposter phenomenon.* Pocket Books.

Hazari, Z., Sadler, P. M., & Sonnert, G. (2013). The science identity of college students:

Exploring the intersection of gender, race, and ethnicity. *Journal of College Science Teaching, 42*, 82-91.

Hansen, M. J., Palakal, M. J., & White, L. (2023). The importance of STEM sense of belonging and academic hope in enhancing persistence for low-income, underrepresented STEM students. *Journal for STEM Education Research.* doi:10.1007/s41979-023-00096-8.

Heaton, J. (2022). "Pseudonyms are used throughout": A footnote, unpacked. *Qualitative Inquiry*, *28*(1), 123-132.

Hensel, N. (2012). *Characteristics of excellence in undergraduate research*.

Herrera, F. A., & Hurtado, S. (2011, April). *Maintaining initial interests: Developing science, technology, engineering, and mathematics (STEM) career aspirations among underrepresented racial minority students.* Association for Educational Research Annual Meeting. New Orleans, LA.

Hezlett, S. A., & Gibson, S. K. (2007). Linking mentoring and social capital: Implications for career and organization development. *Advances in Developing Human Resources*, *9*(3), 384-411.

Holden, C. L., Wright, L. E., Herring, A. M., & Sims, P. L. (2021). Imposter Syndrome among first- and continuing-generation college students: The roles of perfectionism and stress. *Journal of College Student Retention: Research, Theory & Practice*. https://doi.org/10.1177/15210251211019379.

Huecker, M. R., Shreffler, J., McKeny, P. T., & Davis, D. (2022). *Imposter phenomenon.*

Hunn, V. (2014). African Americans students, retention, and team-based learning. A review of the literature and recommendations for retention at predominantly White institutions. *Journal of Black Studies, 45*(4), 302-314.

Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, *91*(1), 36-74.

Hurd, N. M., Tan, J. S., & Loeb, E. L. (2016). Natural mentoring relationships and the adjustment to college among underrepresented students. *American Journal of Community Psychology, 57*(3-4), 330-341.

Hurtado, S. (2007). Linking diversity with the educational and civic missions of higher education. *The Review of Higher Education*, *30*(2), 185-196.

Hurtado, S., & Alvarado, A.R. (2015). *Discrimination and bias, underrepresentation, and sense of belonging on campus.*

Hurtado, S., & Ruiz Alvarado, A. (2012). *The climate for underrepresented groups and diversity on campus.*

Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., & Espinosa, L. L. (2009). Diversifying science: Underrepresented student experiences in structured research programs. *Research in Higher Education, 50*, 189-214. doi:10.1007/s11162-008-9114-7

Hurtado, S., Eagan, M. K., 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.

Hurtado, S., Eagan, M. K., Tran, M. C., Newman, C. B., Chang, M. J., & Velasco, P. (2011). "We do science here": Underrepresented students' interactions with faculty in different college contexts. *Journal of Social Issues*, *67*(3), 553-579.

Hurtado, S., & Guillermo-Wann, C. (2013). *Diverse learning environments: Assessing and creating conditions for student success—Final report to the Ford Foundation*. University of California, Los Angeles: Higher Education Research Institute.

Hurtado, S., Milem, J. F., Clayton-Pedersen, A. R., & Allen, W. R. (1998). Enhancing campus climates for racial/ethnic diversity: Educational policy and practice. *The Review of Higher Education*, *21*(3), 279-302.

Hurtado, S., Newman, C. B., Tran, M. C., & Chang, M. J. (2010). Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project. *New Directions for Institutional Research,* 5-15.

Hurtado, S., & Ruiz, A. (2012). The climate for underrepresented groups and diversity on campus. *American Academy of Political and Social Science, 634,* 190-206.

Ilonze, O. J., Avorgbedor, F., Diallo, A., & Boutjdir, M. (2022). Addressing challenges faced by underrepresented biomedical investigators and efforts to address them: An NHLBI-PRIDE perspective. *Journal of the National Medical Association*.

Jeste, D. V., Twamley, E. W., Cardenas, V., Lebowitz, B., & Reynolds III, C. F. (2009). A call for training the trainers: focus on mentoring to enhance diversity in mental health research. *American Journal of Public Health*, *99*(S1), S31-S37.

Johnson, D. R. (2012). Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. *Journal of College Student Development*, 53(2), 336–346.

Jones, M. T., Barlow, A. E., & Villarejo, M. (2010). Importance of undergraduate research for minority persistence and achievement in biology. *The Journal of Higher Education*, *81*(1), 82-115.

Jones, M. C., & Shorter-Gooden, K. (2009). *Shifting: The double lives of Black women in America*. Harper Collins.

Jones, J., Williams, A., Whitaker, S., Yingling, S., Inkelas, K., & Gates, J. (2018). Call to action: Data, diversity, and STEM education. *Change: The Magazine of Higher Learning*, *50*(2), 40-47.

Kameny, R. R., DeRosier, M. E., Taylor, L. C., McMillen, J. S., Knowles, M. M., & Pifer, K. (2014). Barriers to career success for minority researchers in the behavioral sciences. *Journal of Career Development*, *41*(1), 43-61.

Kardash, C. M. (2000). Evaluation of an undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology, 92*, 191-201.

Kilgo, C. A., Sheets, J. K. E., & Pascarella, E. T. (2015). The link between high-impact practices and student learning: some longitudinal evidence. *Higher Education, 69*(4), 509–525. http://www.jstor.org/stable/43648809

Kim, J. H. (2016). *Understanding narrative inquiry: The crafting and analysis of stories as Research*. SAGE.

Kim, A. Y., Sinatra, G. M., & Seyranian, V. (2018). Developing a STEM identity among young women: A social identity perspective. *Review of Educational Research, 88*, 589-625.

Kinzie, J. (2019). The Next Decade of HIPs: Increasing Access, Quality and Equity.

Kinzie, J., Gonyea, R., Shoup, R., & Kuh, G. D. (2008). Promoting persistence and success of underrepresented students: Lessons for teaching and learning. *New Directions for Teaching and Learning*, *2008*(115), 21-38.

Kuchynka, S., Gates, A., & Rivera, L. (2020). *Identity development during STEM integration for underrepresented minority students* (Elements in Applied Social Psychology). Cambridge: Cambridge University Press. doi:10.1017/978110888207.

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter.* AAC&U (American Colleges and Universities), Washington, DC.

Kuh, G. D., Kinzie, J. L., Buckley, J. A., Bridges, B. K., & Hayek, J. C. (2006). *What matters to student success: A review of the literature* (Vol. 8). Washington, DC: National Postsecondary Education Cooperative.

Kuh, G. D., Kinzie, J., Schuh, J. H., & Whitt, E. J. (2011). Fostering student success in hard times. *Change: The Magazine of Higher Learning*, *43*(4), 13-19.

Kumar, S., & Jagacinski, C. M. (2006). Imposters have goals too: The imposter phenomenon and its relationship to achievement goal theory. *Personality and Individual differences*, *40*(1), 147-157.

Laursen, S., Hunter, A. B., Seymour, E., DeAntoni, T., DeWelde, K., & Thiry, H. (2006). Undergraduate research in science: Not just for scientists anymore. *Handbook of College Science Teaching*, 55-66.

Leedy, P. D., & Ormrod, J. E. (2015). *Practical research*. Pearson.

Leung, L. (2015). Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care*, *4*(3), 324.

Lindwall, J. (2019). *The relationship between undergraduate research training programs and motivational resources for underrepresented minority students in STEM: Program participation, self-efficacy, a sense of belonging, and academic performance* (Doctoral dissertation, Portland State University).

Loeb, E., & Hurd, N. M. (2019). Subjective social status perceived academic competence, and academic achievement among underrepresented students. *Journal of College Student Retention: Research, Theory & Practice, 21*(2), 150-165.

Lopatto, D. (2003). The essential features of undergraduate research. *Council on Undergraduate Research Quarterly*, *24*(139-142).

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First findings. *Cell Biology Education*, *3*(4), 270-277.

Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE—Life Sciences Education, 6*(4), 297-306.

Lopatto, D. (2008). Exploring the benefits of undergraduate research experiences: The SURE survey. *Creating Effective Undergraduate Research Programs in Science: The Transformation from Student to Scientist*, 112-132.

López, A. M., Rodríguez, J. E., Browning Hawes, K., Marsden, A., Ayer, D., Ziegenfuss, D. H., & Okuyemi, K. (2021). Preparing historically underrepresented trainees for biomedical cancer research careers at Huntsman Cancer Institute/University of Utah Health. *Medical Education Online*, *26*(1).

Ma, J., Pender, M., & Welch, M. (2016). *Education pays 2016: The benefits of higher education for individuals and society*. Trends in Higher Education Series. College Board.

Mabrouk, P. A., & Peters, K. (2000). Student perspectives on undergraduate research (UR) experiences in chemistry and biology. *CUR Quarterly*, *21*(1), 25-33.

Madondo, S. M. (Ed.). (2021). Data analysis and methods of qualitative research: Emerging research and opportunities: Emerging research and opportunities.

Malcom, S. M., & Malcom-Piqueux, L. E. (2013). Critical mass revisited: Learning lessons from research on diversity in STEM fields. *Educational Researcher, 42*(3), 176–178. https://doi.org/10.3102/0013189X13486763.

Malone, K. R., & Barabino, G. (2009). Narrations of race in STEM research settings: Identity formation and its discontents. *Science Education, 93*(3), 485-510. https://doi.org/10.1002/sce.20307

Marcelin, J. R., Siraj, D. S., Victor, R., Kotadia, S., & Maldonado, Y. A. (2019). The impact of unconscious bias in healthcare: How to recognize and mitigate it. *The Journal of Infectious Diseases*, *220*(Supplement_2), S62-S73.

Matthews, A., Allen-Meares, P., Watson, K., Crooks, N., Smith, A., Hart, A., . . . & Kim, S. (2021). The use of strategies from the social sciences to inform pipeline development programs for under-represented minority faculty and students in the health sciences. *Journal of Clinical and Translational Science, 5*(1), E73. doi:10.1017/cts.2020.566

Mau, W. C. J., & Li, J. (2018). Factors influencing STEM career aspirations of underrepresented high school students. *The Career Development Quarterly*, *66*(3), 246-258.

McCabe, J. (2009). Racial and gender microaggressions on a predominantly-White campus: Experiences of Black, Latina/o and White undergraduates. *Race, Gender & Class*, 133-151.

McCluney, C. L., & Rabelo, V. C. (2019). Conditions of visibility: An intersectional examination of Black women's belongingness and distinctiveness at work. *Journal of Vocational Behavior*, *113*, 143-152.

McGregor, L. N., Gee, D. E., & Posey, K. E. (2008). I feel like a fraud and it depresses me: The relation between the imposter phenomenon and depression. *Social Behavior and Personality: An International Journal*, *36*(1), 43-48.

McGee, E. O. (2021). *Black, brown, bruised: How racialized STEM education stifles innovation.* Harvard Education Press.

McGee, E. O. (2020). Interrogating structural racism in STEM higher education. *Educational Researcher*, *49*(9), 633-644.

McGee, E. O. (2016). Devalued Black and Latino racial identities: A by-product of STEM college culture? *American Educational Research Journal, 53*(6), 1626–1662.

McGee, E., & Bentley, L. (2017). The equity ethic: Black and Latinx college students reengineering their STEM careers toward justice. *American Journal of Education*. https://doi.org/0195-6744/2017/12401-0001$10.00.

McGee, E. O., & Martin, D. B. (2011). You would not believe what I have to go through to prove my intellectual value! Stereotype management among academically successful Black mathematics and engineering students. *American Educational Research Journal, 48*(6), 1,347-1,389.

McGee, E., Saran, S., & Krulwich, T. A. (2017). Diversity in STEM: What it is and why it matters. *Science, 358*(6369), 132-133.

Mckee, M. (2022). *AI in qualitative data analysis: Tools and strategies for implementation*. Springer.

McWilliams, C., Nims, B. D., & Dwyer, K. A. (2020). *The development of science identity in undergraduate STEM majors: A case study of urban high school students*.

Means, D. R., Stanton, J. D., Mekonnen, B., Oni, O., Breeden, R. L., Babatola, O., ... & Marshall, B. (2022). A deeper calling: The aspirations and persistence of Black undergraduate students in science at a predominantly White institution. *The Review of Higher Education*.

Merchant, J. L., & Omary, M. B. (2010). Underrepresentation of underrepresented minorities in academic medicine: the need to enhance the pipeline and the pipe. *Gastroenterology*, *138*(1), 19-26.

Merolla, D. M., & Serpe, R. T. (2013). STEM enrichment programs and graduate school matriculation: The role of science identity salience. *Soc Psychol Educ, 16*, 575–597. https://doi.org/10.1007/s11218-013-9233-7.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Mertler, C. A. (2022). *Introduction to educational research*. Sage Publications, Inc.

Mervis, J. (2003). *NIH program gives minorities a chance to make their MARC.*

Metzger, K. J., Dingel, M., & Brown, E. (2023). No matter what your story is, there is a place or you in science: Students' ability to relate to scientists positively shifts after scientist spotlight assignments, especially for first-generation students and women. *CBE—Life Sciences Education*.

Miller, L. S., Ozturk, M. D., & Chavez, L. (2005). *Increasing African American, Latino, and Native American representation among high achieving undergraduates at selective colleges and universities.*

Miriti, M. N. (2020). The elephant in the room: race and STEM diversity. *BioScience*, *70*(3), 237-242.

Montcalm, D. M. (1999). Applying Bandura's theory of self-efficacy to the teaching of research. *Journal of Teaching in Social Work, 19*(1–2), 93–107. https://doi.org/10.1300/j067v19n01_08.

Morales, E. S. (2009). Contextual community prevention theory: Building interventions with community agency collaboration. *American Psychologist*, *64*(8), 805.

Morales, E. M. (2014). Intersectional impact: Black students and race, gender, and class microaggressions in higher education. *Race, Gender & Class*, 48-66.

Morgan, D. L. (2023). Exploring the Use of Artificial Intelligence for Qualitative Data Analysis: The Case of ChatGPT. International Journal of Qualitative Methods, 22.

Morin, R. (2015). *Exploring racial bias among biracial and single-race adults: The IAT.*

Morris, N., Brown, T., & Lee, M. (2023). Using AI to support thematic analysis in qualitative research. *Journal of Research Methodology, 31*(4), 401-418.

Morrison, E., & Grbic, D. (2015). Dimensions of diversity and perception of having learned from individuals from different backgrounds: The particular importance of racial diversity. *Academic Medicine, 90*(7), 937-945.

Morton, J. M. (2014). Cultural code-switching: Straddling the achievement gap. *Journal of Political Philosophy*, *22*(3), 259-281.

National Academies of Sciences, Engineering, and Medicine. (2005). *Assessment of NIH minority research and training programs: Phase 3.* Washington, DC: The National Academies Press. https://doi.org/10.17226/11329.

National Academies of Sciences, Engineering, and Medicine (NASEM). (2017). *Fostering integrity in research.* National Academies Press.

National Center for Education Statistics. (2022). *Undergraduate enrollment*. Condition of Education. U.S. Department of Education, Institute of Education Sciences. https://nces.ed.gov/programs/coe/indicator/cha.

National Center for Science and Engineering Statistics (NCSES). 2023. *Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023*. Special Report NSF 23-315. Alexandria, VA: National Science Foundation. https://ncses.nsf.gov/wmpd.

National Research Council. 2005. *Assessment of NIH Minority Research and Training Programs: Phase 3*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11329.

NC State University. (n.d.). *Diversity, equity, and inclusion*. Equity-And-Inclusion. https://www.ncsu.edu/diversity-equity-and-inclusion/.

Ndoye, A. (2023). High-Impact Practices and Student Performance. *International Journal of Teaching and Learning in Higher Education*, *35*(2), 115-124.

Nealy, S., & Orgill, M. (2019). Postsecondary underrepresented minority STEM students' perceptions of their science identity. *Journal of Negro Education*, *88*(3), 249-268.

National Institutes of Health. (2019). *Notice of NIH's interest in diversity (NOT-OD-20-031)*. Retrieved from https://grants.nih.gov.

National Science Board. (2018). *Science and engineering indicators 2018* (Tech. Rep. No.NSB-2018-1). National Science Foundation. https://www.nsf.gov/statistics/indicators

NC State University. (2022). NC State 2022 Chancellor's Report.

https://chancellor.ncsu.edu/wp-content/uploads/sites/3/2022/12/NC-State-University-Chancellors-Annual-Report-2022.pdf.

Nora, A., & Cabrera, A. F. (1996). The role of perceptions of prejudice and discrimination on the adjustment of minority students to college. *The Journal of Higher Education*, *67*(2), 119-148.

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in STEM. *Harvard Educational Review, 81*(2), 172–209.

Opie, T. R., & Phillips, K. W. (2015). Hair penalties: The negative influence of Afrocentric hair on ratings of Black women's dominance and professionalism. *Frontiers in Psychology*, *6*, 1,311.

Oseguera, L., Park, H. J., De Los Rios, M. J., Aparicio, E. M., & Johnson, R. (2019). Examining the role of scientific identity in Black student retention in a STEM scholar program. *Journal of Negro Education*, *88*(3), 229-248.

O'Donnell, K., Botelho, J., Brown, J., González, G. M., & Head, W. (2015). Undergraduate research and its impact on student success for underrepresented students. *New Directions for Higher Education*, *2015*(169), 27-38.

Osborn, J. M., & Karukstis, K. K. (2009). The benefits of undergraduate research, scholarship, and creative activity. *Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact*, 41-53.

Owens, E. W., Shelton, A. J., Bloom, C. M., & Cavil, J. K. (2012). The significance of HBCUs to the production of STEM graduates: Answering the call. *Educational Foundations, 26,* 33-47.

Packard, B. W.-L. (2016). Successful STEM mentoring initiatives for underrepresented students: A research-based guide for faculty and administrators. *Stylus Publishing.*

Parkman, A. (2016). The impostor phenomenon in higher education: Incidence and impact. *Journal of Higher Education Theory and Practice, 16*(1), 51-60.

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice*. Sage publications.

Peteet, B. J., Montgomery, L., & Weekes, J. C. (2015). Predictors of imposter phenomenon among talented ethnic minority undergraduate students. *The Journal of Negro Education*, *84*(2), 175-186.

Pew Research Center. (2018). *Women and men in STEM often at odds over workplace equity*. Washington, DC: Pew Research Center.

Pfund, C., Byars-Winston, A., Branchaw, J., Hurtado, S., & Eagan, K. (2016). Defining attributes and metrics of effective research mentoring relationships. *AIDS and Behavior, 20,* 238-248.

Prunuske, A., Wilson, J., Walls, M., Marrin, H., & Clarke, B. (2016). Efforts at broadening participation in the sciences: An examination of the mentoring experiences of students from underrepresented groups. *CBE—Life Sciences Education, 15*(3).

Quaye, S. J., & Harper, S. R. (2014). *Student engagement in higher education: Theoretical perspectives and practical approaches for diverse populations*. New York, NY: Routledge.

Rahim, M. A. (2011). Managing conflict in organizations. Transaction Publishers.

Roberts, R., English, C., & Alston, A. (2020). Fostering identity development in teacher preparation: Service-learning's role in empowering agricultural education majors to teach

STEM concepts. *Journal of Agricultural Education, 61,* 214-232. doi:10.5032/jae.2020.03214

Robnett, R. D., Chemers, M. M., & Zurbriggen, E. L. (2015). Longitudinal associations among undergraduates' research experience, self-efficacy, and identity. *Journal of Research in Science Teaching, 52*(6), 847–867. https://doi.org/10.1002/tea.21221

Rollock, N. (2012). Unspoken rules of engagement: navigating racial microaggressions in the academic terrain. *International Journal of Qualitative Studies in Education*, *25*(5), 517-532.

Russell, M. L., & Atwater, M. M. (2005). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a predominantly White institution. *Journal of Research in Science Teaching*, *42*(6), 691-715.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science*, *316*(5824), 548-549.

Sabatini, D. A. (1997). Teaching and research synergism: The undergraduate research experience. *Journal of Professional Issues in Engineering Education and Practice*, *123*(3), 98-102.

Saldana, J. (2022). *The coding manual for qualitative researchers*. (4th ed.). Sage publications.

Saldana, J. (2016). *The coding manual for qualitative researchers*. (3rd ed.). Sage publications.

Schultz, P. W., Hernandez, P. R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., & Serpe, R. T. (2011). Patching the pipeline: Reducing educational disparities in the sciences through minority training programs. *Educational Evaluation and Policy Analysis*, *33*(1), 95-114.

Secules, S., McCall, C., Mejia, J. A., & et al. (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *J Eng Educ., 110,* 19–43. https://doi.org/10.1002/jee.20377.

Secules, S., McCall, C., Mejia, J. A., Beebe, C., Masters, A. S., L. Sánchez-Peña, M., Shapiro, J. R., & Neuberg, S. L. (2007). From stereotype threat to stereotype threats: Implications of a multi-threat framework for causes, moderators, mediators, consequences, and interventions. *Personality and Social Psychology Review*, *11*(2), 107-130.

Settles, I. H., et al. (2020). Epistemic exclusion of women faculty and faculty of color: Understanding scholar(ly) devaluation as a predictor of turnover intentions. *Journal of Higher Education*, 91(6), 1029-1057.

Settles, I. H., Buchanan, N. T., & Dotson, K. (2016). Scrutinized but not recognized: (In)visibility and hypervisibility experiences of faculty of color. *Journal of Vocational Behavior, 113*, 62-74.

Shuler, H., Cazares, V., Marshall, A., Garza-Lopez, E., Hultman, R., Francis, T. R. K., ... & Hinton Jr., A. (2021). Intentional mentoring: Maximizing the impact of underrepresented future scientists in the 21st century. *Pathogens and Disease*, *79*(6).

Shvedko, A., Whittaker, A. C., Thompson, J. L., & et al. (2018). Physical activity interventions for treatment of social isolation, loneliness, or low social support in older adults: A systematic review and meta-analysis of randomized controlled trials. *Psychol Sport Exerc.* doi:10.1016/j.psychsport.2017.10.

Slovacek, S. P., Whittinghill, J. C., Tucker, S., Rath, K. A., Peterfreund, A. R., Kuehn, G. D., & Reinke, Y. G. (2011). Minority students severely underrepresented in science,

technology, engineering, and math. *Journal of STEM Education: Innovations and Research*, *12*(1).

Smith, W. A., Allen, W. R., & Danley, L. L. (2007). "Assume the position... you fit the description" psychosocial experiences and racial battle fatigue among African American male college students. *American Behavioral Scientist*, *51*(4), 551-578.

Smith, D. G., & Schonfeld, N. B. (2000). The benefits of diversity what the research tells us. *About Campus*, *5*(5), 16-23.

Snyder, J. J., Sloane, J. D., Dunk, R. D. P., & Wiles, J. R. (2016). Peer-led team learning helps minority students succeed. *Public Library of Science Biology, 14*(3), 1-7. https://doi.org/10.1371/journal.pbio.1002398

Solórzano, D. G. (1998). Critical race theory, race, and gender microaggressions, and the experience of Chicana and Chicano scholars. *International Journal of Qualitative Studies in Education*, *11*(1), 121-136.

Solorzano, D., Ceja, M., & Yosso, T. (2000). Critical race theory, racial microaggressions, and campus racial climate: The experiences of African American college students. *Journal of Negro Education*, 60-73.

Sorensen, N., Nagda, B. R. A., Gurin, P., & Maxwell, K. E. (2009). Taking a "hands on" approach to diversity in higher education: A critical-dialogic model for effective intergroup interaction. *Analyses of Social Issues and Public Policy*, *9*(1), 3-35.

Spradley, J. P. (2016). *The ethnographic interview*. Waveland Press.

Spencer, B. M., Artis, S., Shavers, M., LeSure, S., & Joshi, A. (2022). To code-switch or not to code-Switch: The psychosocial ramifications of being resilient Black women engineering and computing doctoral students. *Sociological Focus*, *55*(2), 130-150.

Spencer, S. J., Logel, C., & Davies, P. G. (2016). Stereotype threat. *Annual Review of Psychology*, *67*, 415-437.

Spencer-Oatey, H., & Franklin, P. (2009). *Intercultural interaction: A multidisciplinary approach to intercultural communication.* Palgrave Macmillan.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613-629.

Steele, C. M. (1999). Thin ice: "Stereotype threat" and Black college students. *The Atlantic Monthly, 284,* 44-54.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797-811.

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 379-440). San Diego, CA: Academic Press.

Strayhorn, T. L. (2019). *College students' sense of belonging: A key to educational success for all students.* Routledge.

Sue, D. W. (2010). Microaggressions: More than just race. *Psychology Today*, *17*.

Sue, D. W., Capodilupo, C. M., Torino, G. C., Bucceri, J. M., Holder, A. M. B., Nadal, K. L., & Esquilin, M. (2007). Racial microaggressions in everyday life: Implications for clinical practice. *American Psychologists, 62*(4), 271-286. doi:10.1037/0003-066X.62.4.271

Sue, D. W. (2006). Multicultural social work practice. John Wiley & Sons.

Suleman, Z., Welsh, A., & Campbell, A. (2020). *A review of themes and promising practices in STEM-based work in equity, diversity, and inclusion.*

Summers, M. F., & Hrabowski III, F. A. (2006). Preparing minority scientists and engineers. *Science*, *311*(5769), 1,870-1,871.

Svyantek, M. (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, *110*(1), 19-43.

Syed, M., Azmitia, M., & Cooper, C. R. (2011). Identity and academic success among underrepresented ethnic minorities: An interdisciplinary review and integration. *Journal of Social Issues, 67*(3), 442-468.

Taraban, R. (2008). *What is undergraduate research, and why should we support it?*

Tatum, B. D. (2008). Cultivating the trust of black parents. *Everyday Antiracism*, 310-313.

Tatum, B. D. (2017). *Why are all the black kids sitting together in the cafeteria? And other conversations about race.* Basic Books.

Theobald, E. J., Hill, M. J., Tran, E., Agrawal, S., Arroyo, E. N., Behling, S., ... & Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *Proceedings of the National Academy of Sciences, 117*(12), 6,476-6,483.

Thiry, H., & Laursen, S. L. (2011). The role of student-advisor interactions in apprenticing undergraduate researchers into a scientific community of practice. *Journal of Science Education and Technology*, *20*, 771-784.

Torres, J. B., & Solberg, V. S. (2001). Role of self-efficacy, stress, social integration, and family support in Latino college student persistence and health. *Journal of Vocational Behavior*, *59*(1), 53-63.

Toven-Lindsey, B., Levis-Fitzgerald, M., Barber, P. H., & Hasson, T. (2015, Summer).

Increasing persistence in undergraduate science majors: A model for institutional support of underrepresented students. *CBE Life Sci Educ., 14*(2). doi:10.1187/cbe.14-05-0082. PMID: 25828403; PMCID: PMC4477728.

Turner, C. S. (2013). Advancing diversity in higher education. *Journal of Diversity in Higher Education, 6*(3), 155.

Turner, C. S. (2013). Advancing diversity in higher education. *Journal of Diversity in Higher Education, 6*(3), 155–157. https://doi.org/10.1037/a0034356

U.S. Department of Health and Human Services. (n.d.a.). *Diversity matters*. National Institutes of Health. https://extramural-diversity.nih.gov/diversity-matters.

U.S. Department of Health and Human Services. (n.d.b.). *Not-OD-20-031: Notice of NIH's interest in Diversity*. National Institutes of Health. https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html

U.S. Department of Health and Human Services. (n.d.c.). *The importance of science identity for inclusion*. National Institutes of Health. https://diversity.nih.gov/blog/2020-12-04-importance-science-identity-inclusion.

U.S. Department of Health and Human Services. (n.d.d). *Marc and U-RISE (T34) summer research experience (SRE) policy*. National Institute of General Medical Sciences. https://www.nigms.nih.gov/training/T34.

Valantine, H. A., & Collins, F. S. (2015). National Institutes of Health addresses the science of diversity. *Proceedings of the National Academy of Sciences*, *112*(40), 12,240-12,242.

Valantine, H. A., Lund, P. K., & Gammie, A. E. (2016). From the NIH: A systems approach to increasing the diversity of the biomedical research workforce. *CBE—Life Sciences Education*, *15*(3).

Villarejo, M., Barlow, A. E., Kogan, D., Veazey, B. D., & Sweeney, J. K. (2008). Encouraging minority undergraduates to choose science careers: Career paths survey results. *CBE—Life Sciences Education*, *7*(4), 394-409.

Vos, M., Çelik, G., & de Vries, S. (2016). Making cultural differences matter? Diversity perspectives in higher education. *Equality, Diversity, and Inclusion: An International Journal*, *35*(4), 254-266.

Wallace, D., Abel, R., & Ropers-Huilman, B. (2000). Clearing a path for success: Deconstructing borders through undergraduate mentoring. *The Review of Higher Education*, *24*(1), 87-102.

Washington-Harmon, T. (2022, May 23). This survival tactic many BIPOC use could be harmful to their mental health. *Health.* https://www.health.com/mind-body/health-diversity-inclusion/code-switching.

Welcome • institutional strategy and analysis. Institutional Strategy and Analysis. (2022, February 22). https://isa.ncsu.edu/.

Wenzel, T. (2003). *Definition of undergraduate research*. Department of Chemistry, Bates College.

Wenzel, T. J. (1997). What is undergraduate research? *Council on Undergraduate Research Quarterly, 17*, 163.

Whittaker, J. A., & Montgomery, B. L. (2012). Cultivating diversity and competency in STEM: Challenges and remedies for removing virtual barriers to constructing diverse higher education communities of success. *Journal of Undergraduate Neuroscience Education*, *11*(1), A44.

Whitcomb, K. M., & Singh, C. (2021). Underrepresented minority students receive lower grades and have higher rates of attrition across STEM disciplines: A sign of inequity? *International Journal of Science Education, 43*(7), 1,054-1,089.

White, V., Alexander, J., Prince, D., & Verdell, A. (2018). The impact of student engagement, institutional environment, college preparation, and financial support on the persistence of underrepresented minority students in engineering at a predominately White institution: A perspective from students. *Journal of Higher Education Theory and Practice, 18*(2).

White, A. M., DeCuir-Gunby, J. T., & Kim, S. (2019). A mixed methods exploration of the relationships between the racial identity, science identity, science self-efficacy, and science achievement of African American students at HBCUs. *Contemporary Educational Psychology, 57,* 54–71. https://doi.org/10.1016/j.cedpsych.2018.11.006.

Whittaker, J. A., & Montgomery, B. L. (2012). Cultivating diversity and competency in STEM: Challenges and remedies for removing virtual barriers to constructing diverse higher education communities of success. *Journal of Undergraduate Neuroscience Education*, *11*(1), A44.

Wilson, Z. S., et al. (2012). Hierarchical mentoring: A transformative strategy for improving diversity and retention in undergraduate STEM disciplines. *Journal of Science Education and Technology*, 21(1), 148–156.

Williams, S. N., et al. (2014). Hidden figures: A framework to address diversity and inclusion in STEM. *Journal of Women and Minorities in Science and Engineering*, 20(4), 317–336.

Wright, B. (1991). *American Indian and Alaska Native higher education: Toward a new century of academic achievement and cultural integrity*.

Wrighting, D. M., Dombach, J., Walker, M., Cook, J., Duncan, M., Ruiz, G. V., & Birren, B. (2021). Teaching undergraduates to communicate science, cultivate mentoring relationships, and navigate science culture. *CBE—Life Sciences Education*, *20*(3).

Yadav, A., Seals, C. D., Sullivan, C. M. S., Lachney, M., Clark, Q., Dixon, K. G., & Smith, M. J. (2020). The forgotten scholar: Underrepresented minority postdoc experiences in STEM fields. *Educational Studies*, *56*(2), 160-185.

Zajacova, A., Lynch, S. M., & Espenshade, T. J. (2005). Self-efficacy, stress, and academic success in college. *Research in Higher Education, 46,* 677-706.

APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL

NC STATE

Carolyn Veale <cpveale@ncsu.edu>

Veale - 26715 - IRB Protocol assigned Exempt status

1 message

IRB Administrative Office <pins_notifications@ncsu.edu> Thu, Jan 18, 2024 at 9:32 AM
Reply-To: ncsuirboffice@ncsu.edu
To: cpveale@ncsu.edu

Date: January 18, 2024
Study Title: Examining the Lived Experiences of Underrepresented Minority Students Engaging in Undergraduate Research in a Historically White Space
NC State eIRB #: 26715
Funding Source: NA

Dear Carolyn Veale,

The research proposal named above has received administrative review and has been approved on January 18, 2024 as exempt from the policy as outlined in the Code of Federal Regulations (Exempt d.2). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

This approval for this research study does not expire, but any changes must be approved by the IRB prior to implementation in accordance with the NC State university regulation and IRB unit standards.

NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NC State University projects, the assurance number is: FWA00003429.

2. Any changes to the research must be submitted and approved by the IRB prior to implementation in accordance with the NC State university regulation and IRB unit standards.

3. If any problems occur, they must be reported to the IRB office within 5 business days.
4. For information regarding study closure or post approval monitoring activities, please refer to the NC State University IRB website.

To request an official, signed approval letter on NC State letterhead, please submit a request on our website under "Request a Letter"

Sincerely,

Jennie Ofstein, Ph.D.
Institutional Review Board (IRB) Director
North Carolina State University
irb-director@ncsu.edu

APPENDIX B: INFORMED CONSENT FORM FOR PARTICIPATION IN RESEARCH

NC STATE UNIVERSITY

Informed Consent Form for Participation in Research

Title of Study: Examining the Lived Experiences of Underrepresented Minority Students Engaging in Undergraduate Research in a Historically White Space
IRB Protocol: 26715
Principal Investigator(s): Carolyn Veale, cpveale@ncsu.edu, 919-513-4077
Funding Source: None
Collaborating Researchers: East Carolina University for Dissertation Research, Dr. David Siegel, Dissertation Chair

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You are invited to take part in a research study. Here are some important things to know:

- Your participation in this study is voluntary. You can choose not to participate without penalty. If you decide to participate and change your mind, you can stop participating at any time without penalty.
- The purpose of this research study is to examine the narratives of underrepresented minority (URM) STEM undergraduates engaging in undergraduate research.
- You will be asked to respond to interview questions that involve your undergraduate research experience.
- You are not guaranteed any personal benefits from being in this study. Research studies may pose risks to those who participate.
- You may want to participate in this research because understanding the research experience of URM STEM students may benefit future URM STEM students engaging in research in historically white spaces. You may not want to participate in this research because understanding your experiences and what could be done to support you and other students is important.
- If you have questions about your participation in this research at any time, do not hesitate to contact the researcher(s) named above or the NC State IRB office via email at IRB-Director@ncsu.edu or via phone at 1-919-515-8754

Please read the rest of this consent form for more specific details of this research. If you do not understand something, please ask the researcher for clarification or more information.

What is the purpose of this study?
The purpose of the study is to examine the lived experiences of URM STEM students engaging in research at a historically White institution. URM STEM students' narratives will be collected and analyzed for themes that may shed light on their experiences and indicate what areas they need support.

How many people will be in the study?
There will be approximately 7-12 participants in this study.

Am I eligible to be a participant in this study?
In order to be a participant in this study, you must agree to be in the study and be a URM STEM student engaging in undergraduate research.

NC STATE UNIVERSITY

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to do all of the following:

1. Engage in a 1-2 hour interview.
2. Agree to have the researcher audio record your interview.
3. You will be provided a copy of your research data so that you can confirm the accuracy of the information collected. You can indicate if there's any information or identifiers you want us to delete or not share.

The total amount of time that you will be participating in this study is 1-2 hours.

Recording in research
Participants will be audio recorded. If you do not want this information collected, you cannot participate in this research.

We would like to use the recordings for transcribed and implemented in dissertation findings. We will keep these transcriptions and recordings for three years.

Benefits to participating in this research

There are no direct benefits to your participation in the research. The indirect benefits are having the opportunity to tell your story as it relates to your undergraduate research engagement.

Risks to participating in this research
There is minimal risk associated with your participation in this research.

How will my identity and the data about me be stored and protected?
After all data is collected, the researchers will go through the data and remove all direct identifiers and retain indirect identifiers with the data.

How will the data about me be reported to the public and are there risks associated with that?

We may quote you or share specific responses from you in our publications and presentations but we will not include your name or any other information that could easily identify you. As a result, there are minimal risks to you as a result of how we report the data.

This information is collected by audio recording. The reason this is being collected is to properly respond to the dissertation research questions. One lawful basis for doing so is your consent. The information will be used for 1-2 years and will be used for research purposes. The data will be stored for 3 years and the data will be shared with the research committee and inquiry partners including the Office of Undergraduate Research, University Honors Program, and Principal Investigators in undergraduate research labs. The information will not be shared with someone in another country under the lawful basis of your consent and the legitimate interest of research. If the data is shared, it will be shared in a completely de-identified format.

NC STATE UNIVERSITY

The effect of the collecting of this data to you is not applicable. The use of your information is unlikely to cause harm to you. If you would like to request access to the information from this project about you, rectify the information about you, or remove all of your information from this research project, you may do so by contacting the researcher named above unless it is impossible to identify your information amongst the other data.

Right to withdraw your participation
Your participation is voluntary. Even if you agree initially, consent is an ongoing process. You can stop participating at any time for any reason. To do so, just simple communicate you no longer want to participate. You can also contact the researcher, Carolyn Veale, at cpveale@ncsu.edu and 919-696-3853.

If you withdraw, we will stop any procedures or data collection that may be happening. We will also delete any data that's already been collected from you whenever possible. We will not be able to delete your data if we cannot identify which responses are yours or if the data has already been published.

Compensation
There is no compensation for participating in this study.

What if you are a student?
Your participation in this study is not a course requirement. Your participation or lack thereof will not affect your class standing, grades, or relationship with your instructors or advisors.

What if you have questions about this study?
If you have questions at any time about the study itself or the procedures implemented in this study, you may contact the researcher, Carolyn Veale at cpveale@ncsu.edu and 919-51304077.

What if you have questions about your rights as a research participant?
If you have questions about your rights as someone taking part in research, you may call the ECU University and Medical Center Institutional Review Board (UMCIRB) at phone number 252-744-2914 (days). If you would like to report a complaint or concern about this research study, you may call the Director for Human Research Protections, at 252-744-2914.

Consent to participate
By signing this consent form, I am affirming that I have read the above information. All of the questions that I had about this research have been answered. If I consent to participate, I understand that I can stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I am aware that I may revoke my consent at any time.

☐ **Yes, I want to be in this research study.**

Name_____ **Today's Date** _____

☐ **No, I do not want to be in this research study.**

Thank you for your consideration.

APPENDIX C: INTERVIEW PROTOCOL AND QUESTIONS

INTERVIEW PROTOCOLPART I. INTRODUCTION

Thank you for your willingness to take part in the in-depth interview aspect of my research study. My research is to examine the lived experiences or underrepresented minority students defined by the National Institute of Health engaging in undergraduate research in a historically White space (NC State University). The interview's purpose is to understand your lived experience from a researcher's perspective. I am not here to push any agenda as it relates to your research. I am interested in the true and authentic nature of your research experience. I am interested in your experience with your research mentor and other individuals in the research setting. I am interested in what you experience in the research space and how this experience has affected your academic life, your science identity formation, and your future academic/career endeavors. Your participation is voluntary. If you do not feel comfortable answering any question, you have the right to pass on that question. If you feel uncomfortable during the interview, please tell me and we can stop at any time.

PART II. CONSENT

I have provided you with a copy of the consent form. This consent form indicated I need permission from you to audio record our conversation today. This recording's purpose is to ensure that I get an accurate description of your narrative while still present with the interview. I will also be taking notes. Are you okay with me recording this conversation today?

_____ YES _____ No

If yes: Thank you for your willingness as it relates to me recording this interview. Please tell me if you want me to stop the recording or if I need to strike something you said in it.

If no: Thank you for letting me know. I will only take notes of this conversation instead.

Before we continue with the interview do you have any questions?

I have (X) questions that I will ask you. The number of questions asked can increase if I need more clarity of something you have said. If any question(s) arise at any point in this interview, feel free to ask them. I am more than willing to respond to any question(s) you may have.

To protect your identity, you have the option of selecting a pseudonym for yourself. The name you choose will represent your story/data collected and will be indicated in the study to keep

your identity confidential. Do you want to continue with your chosen pseudonym on the consent form and do you have a pseudonym in mind?

_____ Yes _____ No

PART III. INTERVIEW QUESTIONS

1. Tell me about yourself and how you decided to come to NC State and major in STEM.
    a. *Potential inquiry as it relates to various identities and how they connect.*
2. Tell me about your experiences as an underrepresented minority in science/research at NC State University.
    a. *What impact have identities had on experiences?*
3. How did you come to engage in undergraduate research?
4. What has been your experience in the research setting?
5. Discuss your interactions with principal investigators, post docs, graduate students, and other undergraduates in the research setting.
6. Can you describe the mentorship relationships you have cultivated? (e.g., PI, post docs, and graduate level mentors).
7. Discuss your confidence in your ability to successfully navigate undergraduate research.
8. What do you perceive as the barriers/challenges in the research setting for you?
9. From your perspective what could be done to improve your undergraduate research experience?
10. When did you begin to see yourself as a research scientist and has that changed?
11. How does your research experience differ from your classroom experience?
12. Where do you see yourself within the first year after completing your undergraduate degree and has this changed from your original plan?
13. Where do you see yourself in the next ten years?
14. Do you want to share anything else with me now?

APPENDIX D: CONSENT LETTER

CONSENT LETTER

Dear T34 Trainee,

You are invited to participate in a research study **Examining the Lived Experiences of Underrepresented Minority Students Engaging in Undergraduate Research in a Historically White Space** that I am conducting as a doctoral student in the Department of Educational Leadership at East Carolina University.

The goal of my study is to explore intersectionality of cultural competence, intercultural conflict management style, and science identity development of URM undergraduate STEM students engaging in undergraduate research in a historically White space. The study will also explore the lived experiences of these students. Your participation is strictly voluntary, and your responses are confidential. There is no penalty for not taking part in this research study and you can withdraw at any time.

Please email my chair Dr. David Siegel at siegeld@ecu.edu for any research questions or the University & Medical Center Institutional Review Board (UMCIRB) at 252-744-2914 for questions about your rights as a research participant.

Sincerely,

Carolyn Veale

ECU Doctoral Student – Educational Leadership

APPENDIX E: NC STATE T34 CONFLICT RESOLUTION PROTOCOL

Conflict Resolution Protocol

Point of contact (PC) for all conflict resolution issues will be the Program Manager, Ms. Carolyn Veale. Ms. Veale has extensive conflict resolution experience and has often dealt with faculty-faculty, trainee/trainee, and faculty/trainee conflict.

In the case that the conflict involves any of the MPIs, or their trainees, <NAME>, the Director of the CBS graduate program, with extensive conflict resolution experience, has agreed to serve as the point of contact (PC). In addition, if the mentor involved in the conflict is also a member of the CMI executive committee, they will be identified as being in conflict of interest and will not be allowed to be present, or vote, in any discussion related to that specific conflict.

It should be noted that these protocols relate only to the T34 training program and do not supersede NC State formal policies and procedures available to undergraduate students (https://policies.ncsu.edu/regulation/reg- 11-40-02/). Those procedures involve situations such as grade grievances, academic performance grievances and more serious charges of sexual or racial discrimination. Nor can the T34 supersede undergraduate program specific minimum requirements. The protocols below are specific to the T34 mentor/trainee interactions and training program inclusion/exclusion.

T-34 Conflict Resolution Protocol

1. Trainee and/or mentor contact point of contact (PC). This initial contact will be used to describe the conflict. PC will do an initial assessment of the seriousness of the conflict and will determine if this conflict can be addressed at the T34 level or whether it must be moved to the university level or undergraduate program level (see above). If it can be addressed at the T34 level, then it will move to step

2. Point of contact will organize a meeting in their office with the other affected parties (Faculty/Graduate/postdoc mentor if trainee brought conflict forward, or trainee if faculty/graduate/postdoc mentor brought conflict forward). In this meeting, additional information will be obtained to determine how best to move to a conflict resolution stage. Main issues that need to be addressed will be identified by PC after hearing from all affected parties. PC will determine if attempts at conflict resolutions are needed or whether it is in the best interest of the T34 trainee to find an alternate mentor.

3. If the PC and faculty, graduate/postdoc mentor and trainee chose to find a way to move forward, the PC will organize a meeting of all affected parties where specific issues will be addressed. In this meeting, PC will act as mediator and will develop a roadmap for resolving the conflict. They will also determine whether inclusion of the relevant department representatives in future meetings is warranted.

4. PC will present the case to the MPIs (with department/program representatives present if required) to decide one of three possible outcomes

a. Determine if more information is needed and provide the PC with a course of action to gather that information. This may include either the mentor or the trainee being invited to address the MPIs.

b. Find a new mentor for this trainee without finding major deficiencies in either the mentor or trainee.

c. Determine that the mentor is the main cause of the conflict and either recommend specific further training for the mentor or recommend removal from the training program.

d. Determine that the trainee is the main cause of the conflict and either recommend moving to a more experienced mentor or placing the trainee on probation in the training program. If probation goals are not met, MPIs can recommend removal of the trainee from the T34 training program.

APPENDIX F: CONFLICT MANAGEMENT SYTLES QUIZ

Conflict Management Styles Quiz

Source: Reginald (Reg) Adkins, PhD, Elemental Truths
http://elementaltruths.blogspot.com/2006/11/conflict-management-quiz.html

We each have our own way of dealing with conflict. The techniques we use are based on many variables such as our basic underlying temperament, our personality, our environment and where we are in our professional career. However, by and large there are five major styles of conflict management techniques in our toolbox. In order to address conflict, we draw from a collaborating, competing, avoiding, harmonizing, or compromising style of management. None of these strategies is superior in and of itself. How effective they are depends on the context in which they are used.

Each statement below provides a strategy for dealing with a conflict. Rate each statement on a scale of 1 to 4 indicating how likely you are to use this strategy.

1 = Rarely 2 = Sometimes 3 = Often 4 = Always

Be sure to answer the questions indicating how you would behave rather than how you think you behave.

1. I explore issues with others so as to find solutions that meet everyone's needs. _____
2. I try to negotiate and adopt a give-and-take approach to problem situations. _____
3. I try to meet the expectations of others. _____
4. I would argue my case and insist on the merits of my point of view. _____
5. When there is a disagreement, I gather as much information as I can and keep the lines of communication open. _____
6. When I find myself in an argument, I usually say very little and try to leave as soon as possible. _____
7. I try to see conflicts from both sides. What do I need? What does the other person need? What are the issues involved? _____
8. I prefer to compromise when solving problems and just move on. _____
9. I find conflicts challenging and exhilarating; I enjoy the battle of wits that usually follows. _____
10. Being at odds with other people makes me feel uncomfortable and anxious. _____
11. I try to accommodate the wishes of my friends and family. _____
12. I can figure out what needs to be done, and I am usually right. _____
13. To break deadlocks, I would meet people halfway. _____
14. I may not get what I want but it's a small price to pay for keeping the peace. _____
15. I avoid hard feelings by keeping my disagreements with others to myself. _____

How to score the Conflict Management Quiz:

As stated, the 15 statements correspond to the five conflict resolution styles. To find your most preferred style, total the points in the respective categories. The one with the highest score indicates your most commonly used strategy. The one with the lowest score indicates your least preferred strategy. However, if you are a leader who must deal with conflict on a regular basis, you may find your style to be a blend of styles.

Style	Corresponding Statements	Total
Collaborating	1, 5, 7	_____
Competing:	4, 9, 12	_____
Avoiding	6, 10, 15	_____
Harmonizing	3, 11, 14	_____
Compromising	2, 8, 13	_____

Brief Descriptions of the Five Conflict Management Styles

Collaborating Style: Problems are solved in ways in which an optimum result is provided for all involved. Both sides get what they want, and negative feelings are minimized.
Pros: Creates mutual trust; maintains positive relationships; builds commitments.
Cons: Time consuming; energy consuming.

Competing Style: Authoritarian approach. Pros: Goal oriented; quick.
Cons: May breed hostility.

Avoiding Style: The non-confrontational approach. Pros: Does not escalate conflict; postpones difficulty. Cons: Unaddressed problems; unresolved problems.

Harmonizing Style: Giving in to maintain relationships.
Pros: Minimizes injury when we are outmatched; relationships are maintained. Cons: Breeds resentment; exploits the weak.

Compromising Style: The middle ground approach.
Pros: Useful in complex issues without simple solutions; all parties are equal in power. Cons: No one is ever really satisfied; less than optimal solutions get implemented.

CULTURAL COMPETENCE SELF-ASSESSMENT CHECKLIST

This self-assessment tool is designed to help you explore your individual cultural competence. Its purpose is to help you consider your own skills, knowledge, and awareness in your interactions with others, and recognize what you can do to become more effective working and living in diverse environments.

The term "culture" includes not only race, ethnicity, and ancestry, but also the culture (e.g. beliefs, common experiences and ways of being in the world) shared by people with characteristics in common, including, but not limited to: people who are Lesbian, Bisexual, Gay and Transgender (LGBT), people with disabilities, members of faith and spiritual communities, and people within various socio-economic classes. For this tool, the focus is primarily on race and ethnicity.

Read each entry in the **Awareness**, **Knowledge**, and **Skills** sections. Place a check mark in the appropriate column which follows. At the end of each section add up the number of times you have checked that column. Multiply the number of times you have checked "Never" by 1, "Sometimes/Occasionally" by 2, "Fairly Often/Pretty Well" by 3 and "Always/Very Well" by 4. The more points you have, the more culturally competent you are becoming.

This is simply a tool. This is not a test. The rating scale is intended to help you identify areas of strength and opportunities for ongoing personal and professional development.

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Awareness		Never	Sometimes/ Occasionally	Fairly Often/ Pretty Well	Always/ Very Well
Value diversity	I view human difference as positive and a cause for celebration.				
Know myself	I have a clear sense of my own ethnic, cultural, and racial identity and how that is viewed by others with whom I differ.				
Share my culture	I am aware that in order to learn more about others I need to understand and be prepared to share my own culture.				
Be aware of areas of discomfort	I am aware of my discomfort when I encounter differences in race, religion, sexual orientation, language, and/or ethnicity.				
Check my assumptions	I am aware of the assumptions that I hold about people of cultures different from my own.				
Challenge my stereotypes	I am aware of the stereotypes I hold as they arise and have developed personal strategies for reducing the harm they cause.				
Reflect on how my culture informs my judgement	I am aware of how my cultural perspective influences my judgement about what I deem to be 'appropriate', 'normal', or 'superior' behaviors, values, and communication styles.				
Accept ambiguity	I accept that in cross-cultural situations there can be uncertainty and that I might feel uncomfortable as a result. I accept that discomfort is part of my growth process				
Be curious	I intentionally make opportunities to put myself in places where I can learn about difference and establish diverse connections.				
Be aware of my privilege	If I am a white person working with members of BIPOC communities, I recognize that I have inherently benefited from racial privilege, and may not be seen as safe, 'unbiased,' or as an ally.				
Be aware of social justice issues	I'm aware of the impact of social context on the lives of culturally diverse populations, and how power, privilege, and social oppression influence their lives.				
		1 pt x	**2 pt x**	**3 pt x**	**4 pt x**

Knowledge		Never	Sometimes/ Occasionally	Fairly Often/ Pretty Well	Always/ Very Well
Gain from my mistakes	I make mistakes and choose to learn from them.				
Assess the limits of my knowledge	I recognize that my knowledge of certain cultural groups is limited. I make an ongoing commitment to learn more through the lens of cultural groups that differ from my own.				
Ask questions	I listen fully to answers and make the time to advance my knowledge from a variety of existing culturally diverse resources before asking additional questions. I do this so that I don't unduly burden members of marginalized communities with addressing gaps in my cultural knowledge.				
Acknowledge the importance of difference	I know that differences in race, culture, ethnicity etc. are important and valued parts of an individual's identity—I do not hide behind the claim of "color blindness."				
Know the historical and current experiences of those I label as 'others'	I am knowledgeable about historical incidents and current day practices that demonstrate racism and exclusion towards those I label as 'others.'				
Understand the influence culture can have	I recognize that cultures change over time and can vary from person to person, as does attachment to culture.				
Commit to life-long learning	I recognize that achieving cultural competence and cultural humility involves a commitment to learning over a lifetime. I consistently demonstrate my commitment to this process.				
Understand the impact of racism, sexism, homophobia, and other prejudices	I recognize that stereotypical attitudes and discriminatory actions can dehumanize, even encourage violence against individuals because of their membership in groups that are different from mine.				
Know my own family history	I know my family's story of immigration and assimilation.				
Know my limitations	I continue to develop my capacity for assessing areas where there are gaps in my knowledge.				

continued on next page

Knowledge continued		Never	Sometimes/ Occasionally	Fairly Often/ Pretty Well	Always/ Very Well
Be aware of multiple social identities	I recognize that people have intersecting multiple identities drawn from race, gender identity, sexual orientation, religion, ethnicity, etc., and the potential influence of each of these identities varies from person to person.				
Acknowledge inter-cultural and intracultural differences	I acknowledge both inter-cultural and intracultural differences.				
Understand point of reference to assess appropriate behavior	I'm aware that everyone has a "culture" and my own "culture" is not to be regarded as the singular or best point of reference to assess which behaviors are appropriate or inappropriate.				
		1 pt x	**2 pt x**	**3 pt x**	**4 pt x**

Skills		Never	Sometimes/ Occasionally	Fairly Often/ Pretty Well	Always/ Very Well
Adapt to different situations	I develop ways to interact respectfully and effectively with individuals and groups that may differ from me.				
Challenge discriminatory and/or racist behavior	I effectively and consistently intervene when I observe others behaving in a racist and/or discriminatory manner.				
Communicate across cultures	I adapt my communication style to effectively interact with people who communicate in ways that are different from my own.				
Seek out situations to expand my skills	I consistently seek out people who challenge me to increase my cross-cultural skills.				
Become engaged	I am actively involved in initiatives, small or big, that promote interaction and understanding among members of diverse groups.				
Act respectfully in cross-cultural situations	I consistently act in ways that demonstrate respect for the culture and beliefs of others.				
Practice cultural protocols	I learn about and put into practice the specific cultural protocols and practices that make me more effective in my work with diverse individuals and groups.				
Act as an ally	My colleagues who are Black, Asian, Latinx, and Indigenous consider me an ally and know that I will support them in culturally appropriate ways.				
Be flexible	I work hard to understand the perspectives of others and consult with diverse colleagues and diverse resources about culturally respectful and appropriate courses of action.				
Be adaptive	I know and use a variety of relationship building skills to create connections with people from whom I differ.				
Recognize my own cultural biases	I recognize my own cultural biases in a given situation and I'm aware not to act out based on my biases.				
Be aware of within-group differences	I'm aware of within-group differences and I do not generalize a specific behavior presented by an individual to the entire cultural community.				
		1 pt x	**2 pt x**	**3 pt x**	**4 pt x**

5 | Cultural competence self-assessment checklist
Adapted with permission from the Central Vancouver Island Multicultural Society

APPENDIX H: ADVANCE TOGETHER COURSE SYLLABUS

HON 298, 498, 499 (T34 Section - Advance Together) Course Syllabus

Honors Research/Independent Study/Honors Research/Creative Project 1/Honors Research/Creative Project 2 or Research Equivalent Course

Fall 2024 - Friday 12-1:30 pm

Instructor Information

Name	Office Phone	Email	Office Location
Carolyn Veale	919-513-4077	cpveale@ncsu.edu	Clark Hall - 207

Office Hours: Available by appointment

Preferred Method of Communication & Response Time

- **Preferred method of communication:** If you need to contact me directly, my preferred method of communication is email. You can expect to receive a response within two business days (i.e., not over the weekend). If I email you directly, please strive to respond within two business days. You should check your NC State email at least once daily to stay on top of course communications.
- **Asking questions about the course:** If you have questions about the course or its content, you can email me or post them on the Student Help Forum in Moodle. You can expect to receive a response within two business days (i.e., not over the weekend).
- **Email guidelines:** Always include a descriptive, specific but concise subject. Include your course number and section in your email and provide adequate context for your question to ensure full understanding of your email.

Course Information

Course Website: NC State Wolfware

Course Credit Hours: 3

Catalog Description

This course offers hands-on faculty-mentored research/creative projects. The section also provides students with a weekly session of Advance Together that includes cohort building, professional and career development, wellness, well-being and research health, community engagement, rigor and reproducibility, and responsible research conduct. Students will meet both virtually and in person

Structure

This course is delivered in a **hybrid** format with asynchronous and synchronous components. Asynchronous components are delivered through **Moodle**, a secure and easy-to-use online learning platform.

Meeting Time and Tool Used

Students will meet on

Prerequisites/Corequisites

Students will be part of the interdisciplinary research training team and registered for three three-hour independent research credit courses.

Minimum Technical and Digital Information Literacy Skills

Required Technical Skills

- Navigate and use Moodle, NC State's Learning Management System.
- Use Gmail, including attaching files to email messages.
- Create and submit files in commonly used word processing program formats (MS Word, text editors, Google Docs).
- Download and install software as needed.
- Download and upload attachments.
- Use spreadsheets, presentations, graphics programs, and other applications in digital environments.
- Use web conferencing tools, including Zoom and Google Meet.
- Post to discussion boards and forums]

Required digital information literacy skills.

- Perform online research using various search engines and library databases.
- Use computer networks to locate and store files or data.
- Use online search tools for specific academic purposes, including the use of search criteria, keywords, and filters.
- Analyze digital information for credibility, currency, and bias (e.g., disinformation, misinformation)
- Properly cite information sources
- Prepare a presentation on research findings.

General Education Program (GEP) Information

GEP Category Fulfilled

None

GEP Corequisites

None

Course Overview

Learning Outcomes

By integrating the components of Advance Together into the research curriculum, T34 will not only acquire the necessary knowledge and skills for academic and professional pursuits but also develop a holistic understanding of their roles as future researchers and contributors to society. Students will also be equipped to navigate the complexities of their field with integrity, compassion, and a commitment to social responsibility.

Upon completion of this course, students will be able to:

1. Develop strong collaborative skills.
2. Have insight into various graduate programs and opportunities within their field of study.
3. Foster a supportive environment for overall well-being.
4. Understand the importance of research ethics and integrity.
5. Develop skills in community outreach, communication, and collaboration.
6. Understand the principles of rigorous scientific inquiry.
7. Promote ethical awareness and understand responsible decision-making.

Course Materials

Required textbook

None

Other required materials

TBD (the program will cover costs)

Optional materials

None

Technology Requirements

NC State University Libraries offers Technology Lending, where many devices can be borrowed for 7 days. Computer labs are available in various locations around campus for student use.

Computer

[E A laptop computer is recommended for students taking this course. NC State's Online and Distance Education provides technology requirements and recommendations for computer hardware, and NC State's Office of Information Technology provides recommendations for your computer at NC State.]

Other devices

None

Software and digitally hosted course components

Moodle and Zoom

Other Student Expenses

None

Communication Guidelines

Respecting our learning community

The NC State Code of Student Conduct outlines classroom behavior expectations (whether virtual or physical) and the consequences for students who violate these expectations. Any behavior that impacts other students' ability to learn and succeed will be addressed but expressing diverse viewpoints and interpretations of course content is welcome.

Community guidelines for this course include:

- Use a respectful tone in all forms of communication (email, written, oral, visual)
- Maintain professionalism (avoid slang, poor grammar, etc.) in your written communication.
- Respect regional dialects and culturally embedded ways of oral communication.
- Stay home or in your dorm room if you are exhibiting symptoms of a contagious illness (fever, chills, etc.).
- Enter our virtual and/or physical classroom community respectfully by refraining from lewd or indecent speech or behavior, helping to maintain a safe physical environment, not using your cell phone for voice or text communication except when explicitly given leave to do so, and not attending class under the influence of any substance.
- Treat each community member respectfully. Do not record others without their consent or engage in hazing, harassment, intimidation, or abuse.
- Respect cultural differences that may influence communication styles and needs.]

Plan for interaction between instructors and students

I am always available to talk to students in and outside of the classroom.

Expectations for learner participation and interaction

Some course activities, including synchronous class sessions, Moodle Forums, and group work, will require you to interact with other students in the course. Communication expectations, including frequency and content, are detailed in the information about each assignment or activity when it appears in the course.

Course Schedule

Please note: the course schedule is subject to change.

Week	Topic	Focus Component	Mode and Activities	Guests and Location

August 30	Graduate and Professional School	Professional and Career Development	In-person	The Mechanics of the Graduate School Application Dr. David Shafer Associate Dean of Graduate School NC State University
September 6	Graduate and Professional School	Professional and Career Development	In-person	University Fellowships Office Dr. Kristen Hetrick Clark Hall
September 13	Graduate and Professional School	Professional and Career Development	In-person	The Ins and Outs of Graduate School Application Review Dr. Ashley Brown Dr. Jorge Piedrahita
September 18 PLEASE NOTE THIS IS A WEDNESDAY AT 1:00 PM	Graduate and Professional School	Professional and Career Development	In-person	Duke University MSTP Program Andrea Perfetto Liu Assistant Dean of Admissions Assistant Director of MSTP Clark Hall
September 27	Title IX	Wellness, Well-Being, and Research Health	Virtual	Addressing Sexual Harassment in Biomedical Sciences Moodle Platform
October 4	Enhancing Reproducibility through Rigor & Transparency	Rigor and Reproducibility	Virtual Assignment	Reproducibility Training Modules Moodle Platform
October 11	Mid-Semester Check-in	Wellness and Well-Being	In-person	In-person one-on-one with the Program Manager
October 19	Community Engagement	Community Engagement	In-person	NC State Open House
October 25		Wellness, Well-Being, & Research Health	Virtual	TBD
November 1	Time Management	Wellness, Well-Being	Virtual	TBD

November 8	Student Presentations	Professional and Career Development	In-person	TBD
November 15	Student Presentations	Professional and Career Development	In-person	TBD
November 22	End of Semester Outing	Cohort Building	In-person	TBD

Course Policies

Proctored exams

NA

Late assignments

Late assignments will be accepted and generally without penalty. Please communicate with the instructor regarding any late assignments.

Incomplete grades, withdrawals

Information on incomplete grades can be found at REG 02.50.03 – Grades and Grade Point Average. If you encounter a serious disruption to your work not caused by you and you would have otherwise completed the course, contact your instructor as soon as you can to discuss the possibility of earning an incomplete in the course for the semester, including an agreement on when the remaining work must be done to change the grade to the appropriate letter grade.

If your student must withdraw from a course or the University due to hardship beyond their control, see Withdrawal Process and Timeline | Student Services Center for information and instructions.]

Attendance

- Attendance is required.
- Excuses for unanticipated absences must be presented to the instructor within one week after the return to class.
- Students are responsible for making up any missed work.

Related NC State Policy: REG 02.20.03 – Attendance Regulations

University Policies

Academic integrity and honesty

Students must comply with the university policy on academic integrity found in the Code of Student Conduct 11.35.01, sections 8 and 9. Therefore, students must uphold the Pack Pledge: “I have neither given nor received unauthorized aid on this test or assignment.” The Student Discipline Procedures will handle violations of academic integrity.

Please refer to the Academic Integrity web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

Student privacy

Originality Checking Software

Software is not used in this course to detect the originality of student submissions.

Class recording statement:

NA - students will be informed of class recordings.

Class privacy statement:

This course requires online exchanges between students and the instructor, but NOT with persons outside the course. Students may be required to disclose personally identifiable information to other students in the course via electronic tools like email or web postings where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

Student Resources

Academic and Student Affairs maintains a website with links for student support on campus, including educational support, community support, health and wellness, financial hardship, or insecurity, and more. Find Help on Campus.

Disability resources

Reasonable accommodations will be made for students with verifiable disabilities. To take advantage of available accommodations, students must register with the Disability Resource Office (DRO). For more information on NC State's policy on working with students with disabilities, please see the Policies, Rules, and Regulations page maintained by the DRO and REG 02.20.01 Academic Accommodations for Students with Disabilities.

Trans-inclusive statement

[Example: To affirm and respect the identities of transgender students in the classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than what is listed in the student directory.]

Basic needs security

[Example: Any student who faces challenges securing their food or housing, needs emergency financial assistance, or has any other help with basic needs can find support through Pack Essentials. If you have an extenuating circumstance affecting your ability to succeed in your courses, talk with your academic advisor, instructor, or other trusted staff member on campus.]

Syllabus Modification Statement

Our syllabus represents a flexible agreement. It outlines the topics we will cover and the order in which we will cover them. Assignment due dates represent the earliest possible time they would be due. Minor changes in the Advance Together syllabus can occur.