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Cracking the Code: Chief Admission Officers' Solutions for Inclusive STEM Admissions in Public Research Universities

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Chief Admission Officers' Solutions for Inclusive STEM Admissions in Public Research Universities

By

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Abstract

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This study examined the role of chief admission officers (CAOs) in Research 1 (R1) public flagship institutions and how they understand and address the misalignment between admission criteria to STEM majors and the disparate access to STEM opportunities for diverse students in the applicant pool. The research questions this study explored were (a) how the case CAOs characterized and analyzed the challenges that underrepresented minority (URM) applicants face in the admission process to STEM majors and (b) what strategies CAOs employ to overcome these challenges and provide access to STEM majors for URM students. Guided by critical race theory in education and anti-deficit theory to interrogate the STEM admission pipeline and excavate strategies that provide access to STEM majors, qualitative data was collected at six R1 public flagship institutions. This qualitative study explored various data sources, including a leadership questionnaire, and semi-structured one-on-one interviews with chief admission officers, as well as an examination of institutional admission websites and publicly available admission data.

The study's findings reveal that CAOs characterize the challenges as institutional and environmental factors contributing to an admission pathway that disproportionately keeps URM students from pursuing STEM majors. Institutional factors include interpretations of the public flagship missions and current enrollment goals that are at odds with diversifying STEM and the additional admission criteria for STEM applicants. The study also highlights the significant impact institutional faculty have on setting admission guidelines. Environmental factors that impact college admission include varied educational contexts of the applicant pool, academic opportunity gaps amongst students, and other neighboring institutions. To address the misalignment of college admission requirements and the lived experiences of their applicant pools, CAOs employ strategies like pipeline development, nuanced application evaluation, and embedding equity values in admission staff. After examining the history of exclusion in higher education and current college admission practice, this study concludes that while the STEM admission pipeline to public universities is skewed to keep URM students from participating, CAOs have strategies to ameliorate the impact. With implications for policy development, best practices, and future research this study provides insights for public university faculty and

admission professionals to reconsider admission policies, definitions of merit and meritocracy in admission.

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Acknowledgments

To my son, Ifedayo. You are the best of all that I am and have brought so much love into my life while the world is on fire. Thank you for requiring my presence and patience.

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Chapter 1: Introduction

More than ever, there has been a growing skepticism around the value of participating in higher education in the United States. With the prosperity of the U.S. economy stalling for many middle- and low-income families, rising inflation, and the soaring cost of attending universities, the faith in the ROI of the university experience is no longer implicit. One area of academic interest that continues to see a thriving industry attached is the broad and growing fields of science, technology, engineering, and math (STEM). Whether it is climate change, medical innovations, or the countless variations of engineering, the interest in STEM is no longer attractive only to unique sectors of the population; with growing engagement from diverse groups of students, they have become the most sought-after majors on college campuses. However, it is questionable if the academic environment of STEM is ready to expand and include new faces, perspectives, and experiences to fuel its innovation. As the interest in STEM majors rises alongside the prosperous tech industry, a socioeconomic disparity emerges along racial lines, contributing to the underrepresentation of minority groups in STEM majors and the STEM industry. Examining this phenomenon through the lens of critical race theory in education (Ledesma & Calderón, 2015) allows researchers to understand the educational systems and experiences perpetuating this inequity and define students as unprepared. Struggles arise for Black and Latinx students as they navigate tensions between the expectation to engage in courses signaling STEM academic competitiveness and the limited accessibility historically marginalized students face, creating a systemic barrier to their pursuit of STEM majors. It is these tensions that erect barriers for Black and Latinx students to access STEM in higher education.

The importance of this tension grows as the Western Interstate Commission on Higher Education's (WICHE) "Knocking on the College Door" report (Bransberger, 2021) has consistently shown a dramatic diversification of the K–12 pipeline since the Great Recession of 2007. WICHE explained that the increasing diversification only adds more weight to the imperative for postsecondary education to better support students who have traditionally been underserved and to address systemic inequities more broadly (Bransberger, 2021). The tension between college access and STEM standards is amplified when the institution has a public-access mission and Research 1 (R1) designation. Public R1 institutions are defined as (a) members of the National Association of State Universities and Land Grant Colleges and (b) as of this writing, recognized by the Carnegie Foundation with a 15, 16, or 17 value in its 2004 basic classification (McCormick & Zhao, 2005). There are only 63 public R1 institutions, and these schools produce very high research activity and confer doctoral degrees. Through the application of Sean Harper's (2010) anti-deficit framework and Walton et al.'s (2013) theory on affirmative meritocracy, in this study I seek to understand how chief admission officers (CAOs) navigate this tension to provide access for underrepresented minority (URM) students. Through the tenets of critical race theory in education (Ledesma & Calderón, 2015), this analysis emphasizes the systems, structures, and educators that influence college access for URM students.

Purpose of Research

This research examines CAOs and how they understand and address the STEM pipeline for underrepresented students. Through examining the relationship between selective college admission criteria to STEM majors and the disparities of access for Black and Latinx students to competitive high-school STEM curricula, this research highlights systemic barriers and institutional strategies admission leaders engage to provide opportunity and access for URM applicants to STEM majors. As a consequence of race- and class-based stratification of high-school opportunities, postsecondary enrollment patterns are stratified by race and income along with institutional selectivity (Posselt et al., 2012). This study explores the role of CAOs at R1 public flagship institutions in addressing the impacts of patterns of oppression that are upheld by college admission requirements and their misalignment with high-school STEM offerings for URM students. Recognizing that these admissions professionals need to use traditional measures of merit, as alternative measures are not yet widely adopted, this research seeks to excavate the strategies CAOs employ and barriers they face to provide access to STEM majors for URM students. The research questions used for this inquiry are as follows:

- How do chief admission officers in R1 public flagship universities characterize and analyze the challenges and inequities that URM STEM applicants face in the admission process?
- Are there ways that chief admission officers of R1 public flagship universities create opportunity and access to STEM majors for URM students?

Significance of Research

The competitiveness for admission to selective colleges is rising, and the applicant pool is diversifying, including more significant numbers of low-income students and students of color attending college. This trend suggests that the misalignment between STEM admission requirements and academic opportunities for these students may worsen, exacerbating disparities in access and representation. Rodriguez (2018) argued that despite the (a) importance of course rigor in college admissions decisions, (b) widespread recognition of the need for greater high-school course alignment with college admission requirements, and (c) well-understood stratification of higher-education enrollment patterns, our knowledge of the link between high-school curriculum and postsecondary admissions standards remains limited. The “high standards” that selective colleges seek are not critiqued to understand who has an opportunity to meet those standards and who is being left behind regardless of their academic promise. Rather than focusing on student attitudes and attributes, which already have a deep research base, this analysis emphasizes the admission systems and CAO beliefs, and the impact these have on CAOs’ ability to create liberation through access for URM students pursuing STEM.

As a college admission professional, I hope to elucidate this systemic inequity while actively seeking admission evaluation practices that have a more equitable outcome. Angela Davis once said, “The challenge of the twenty-first century is not to demand equal opportunity in the machinery of oppression, but rather to identify and dismantle those structures in which racism continues to be embedded” (Davis & Mendieta, 2005, p. 29). Scholarship already addresses the challenges encountered and the resilience developed by Black and Brown scholars at every level of public education. If we recognize that admission to college is not a transaction but an execution of institutional values of belonging and merit, examining the college admission

machine rather than those who must navigate it is critical to best understand and change the representation that exists in STEM.

Key Terminology

To ensure a shared understanding of the language used throughout this paper, it is important to define the terms used fluidly locally throughout the research. bell hooks (2015) says, "The oppressed struggle in language to recover ourselves, to reconcile, to reunite, to renew. Our words are not without meaning, they are an action, a resistance" (p. 145). The following terms will be used throughout the discussion of my research findings:

***STEM*.** To define STEM, I rely upon the categorization utilized by the National Science Foundation's Advance Program (2001), which includes majors such as engineering, physical sciences, earth, atmospheric or ocean sciences, mathematical and computer sciences, data sciences, and biological and agricultural sciences in the STEM category. This definition excludes the social and behavioral sciences and is consistent with how admission officers describe applicants to engineering and other physical science disciplines.

Race. "Race" and "ethnicity" are used interchangeably throughout the studies I surveyed. Although I acknowledge the important distinctions between the constructs, I am constrained by the terminology employed by the literature synthesized. Typically, the primary studies I synthesized categorized students as either Asian (or Asian American, Pacific Islander), Black (or African American), Latinx (Hispanic), Native American (American Indian and Alaskan Native), Other (typically reserved for mixed-race students), or White (European American). These common categories blur meaningful disaggregated ethnic differences relevant to educational outcomes. For instance, among Asians, Hmong and Korean students have distinct outcomes; among Latinx, youth of different national origins are likely to have varied educational opportunity structures. Generations spent in the United States further complicate racial and ethnic categorization because immigrant students frequently perform better than their native-born co-ethnics (Bottia, 2019). Nevertheless, by necessity, I use the terms Black, White, Latinx, Asian, American Indian, and Other to refer to members of the groups discussed above.

***Black*.** Black with a capital 'B' refers to a group of people, many of whose experiences are heavily influenced by the legacies of slavery, state-sanctioned Jim Crow laws, the government-sanctioned crack epidemic and war on drugs, and the prison industrial complex. It also refers to those whose ancestors were born in Africa and willfully immigrated to the United States from other parts of the world. I will use the term *Black* unless specifically citing research that categorizes the same group as African American.

***Latinx*.** Latinx is a gender-neutral term used to describe individuals who trace their origins to the Spanish-speaking countries and regions of Latin America (Mexican, Puerto Rican, etc.). *Latinx* embraces the challenge to gender binaries posed by LGBT, genderqueer, and nonnormative gender activists and intellectuals. Although the term is not one commonly used in the community upon which it is cast, Latinx reflects the shifting terrain of identification and the ongoing commitment to building unity through embracing the diversity of *Latinidad* by not

erasing difference and specificity (Soto Vega & Chávez, 2018). I will use *Latinx* in reference to the race, ethnicity, or culture of this diverse group throughout my research unless specifically citing authors that categorize the same people differently.

Underrepresented Minority (URM). The term *underrepresented minority* is standard nomenclature in the higher-education admissions space. As a practitioner, when we are talking about higher education and STEM representation, the term *URM* refers specifically to those who belong to the ethnic and racial groups of Black, Latinx, American Indian, Pacific Islanders, and Alaskan Native peoples.

Chief Admission Officer (CAO). *CAO* describes the individual responsible for the admission of undergraduates. This individual may also be responsible for recruitment and selection and for the admission of graduate and professional students or for scholarship administration or similar functions (Schulz & Lucido, 2011).

Dissertation Overview

Nine chapters are used to organize this study. The first chapter provided the reader with a fundamental introduction to the growing tension of what is happening in college admission in regard to admission policies and K–12 experiences. Chapter 2 provides an analysis of the entities that shape the mental models of merit and the history of the college admission profession. This history and understanding of college admission is important as we examine STEM admission. Comprising the most exclusive and selective majors for college applicants, STEM admission somewhat replicates the historical tactics of exclusivity that were born at the origin of the admission profession. Chapter 3 explains the theoretical frameworks used throughout this research and offers a review of pertinent literature surrounding the STEM pipeline to colleges. Chapter 4 details the methodology surrounding the research design, participant choice, data collection, positionality of the researcher, and data analysis. Chapter 5 provides an overview of the leaders in this study and their respective campuses. In Chapters 6, 7, and 8, I analyze the data and results and present findings. In Chapter 9, I discuss the findings of the study and situate them with relevant literature, present implications for further inquiry, and conclude the study.

Chapter 2: Admission Landscape and the Culture of Exclusion

In order to change the system, educators must see it for what it is. Examining the origins of higher education and college access in America is critical in order to understand how it has been dominated by a culture of exclusion to stratify American society. To dismantle this system and to achieve educational freedom—not merely reform—teachers, parents, and community leaders must approach education with the imagination, determination, boldness, and urgency of an abolitionist. This section provides a brief overview of the origins, purpose, and evolution of secondary schooling, specifically focusing on understanding the formation of the higher-education landscape. Through this focus, I explore the origins of higher-education admission in the United States and the entities that have developed the culture of exclusion that underpins all we know about college admission. Secondly, I provide an overview of the origins of higher education and its expansion after the Civil War. I then speak to the development of community colleges and broader access to higher education. Throughout, I place the evolution of schooling in the context of historical events in the United States.

The history of American education is, in many ways, an expression of the ongoing tension between schooling as the pursuit of gradually evolving cultural ideals and schooling as the pursuit of increasingly compelling economic practicalities (Labaree, 2010). More importantly, as schooling and the importance of schooling became more pronounced in the United States, who deserves to be educated, as communicated through college access, also became central to the progress of building thriving societies across the country. To examine the history of education in the United States is to examine the birth of systems and institutions prior to the Civil War. These institutions include the penitentiary, the hospital, the insane asylum, the poorhouse, and the common school. Each institution was created at a time when the market economy in the United States was growing, as a strategy for helping wage earners deal with needs that obstructed their ability to participate in the labor market. These institutions took care of those who were too criminal (the penitentiary), too sick (the hospital), too crazy (the asylum), too old and poor (the poorhouse), and too young (the school) to earn wages and thus care for themselves (Labaree, 2010).

From their foundations, these institutions were all established as places for teaching and learning. Every correctional officer, nurse, and attendant was considered a kind of instructor. What makes the school exceptional is its focus on the entire cohort of the young rather than a subsection of it (Labaree, 2010). As a result, schooling had goals that were broader and had a much greater potential for societal influence. To address these goals effectively, higher education was conceptualized as an extension of the institution of school.

Origins of Higher Education

American higher education was founded around the mission to serve society and promote democracy (Benson et al., 2007). In the Northwest Ordinance of 1787, the Continental Congress wrote, “Knowledge, being necessary to good government and the happiness of mankind, [therefore] schools and the means of education shall forever be encouraged” (U.S. National Archives and Records Administration, n.d., p. 9). However, despite being conceptualized as a public good, higher education was never intended for the broader society. Parallel to the rise of schooling were signals of its exclusion and elitism; universities were institutions created to serve only segments of the population. The first colonial college, now Harvard University, was founded in 1636 to prepare ministers (Snyder, 1993). Soon after, other institutions across the

northeast, many now known as the Ivy League, were constructed with similar missions: to promote religious ideology. Entrance to these institutions was reserved for White men who had a firm grasp of the classic languages of Greek and Latin. These entrance requirements were not grounded in common knowledge of the broad population at the time. In fact, one-fourth of students were rejected because of deficiencies in Latin, Greek, or sometimes mathematics (Snyder, 1993).

Given the embedded nature of religion in the foundation of higher education, it is no surprise that the rise of Catholic colleges followed the construction of the nation's first institutions. While these additional institutions created greater access to higher education, the target population did not change. A full 200 years after the founding of Harvard University, Wesleyan College in Georgia opened its doors, becoming the first women's college in the world in 1836. The importance of women's colleges cannot be overstated, as many Ivy League institutions still refused to admit women as undergraduates as recently as the 1960s. While viewed as liberal and accessible, women's colleges attracted an economically favored group as students or donors and could thus afford to shape their curriculum toward cultivating a point of view rather than earning a living (McAfee, 1937). As in other moments of liberation for White women in the United States, women of color would be have to attend less-resourced HBCUs.

The evolution of access to higher education did not happen in a vacuum and is, in fact, a historical account of the formation of American society. Prior to the Civil War, the United States was still explicitly peddling slavery and the subjugation of Black and Brown bodies for profit. Only approximately 40 Blacks had graduated from colleges and universities, all of these located in the North, by the start of the war (Titcomb, 2014). In 1862, President Abraham Lincoln signed the Morrill Act, under which Congress granted to each state 30,000 acres of land for each representative and senator "for the endowment, support, and maintenance of at least one college where the leading object shall be—without excluding other scientific and classical studies, and including military tactics—to teach branches of learning as are related to agriculture and mechanic arts" (Act of July 2, 1862 [Morrill Act], 1862, Sec. 4).

This landmark decision gave birth to land-grant colleges and universities all across the country. People of color were often excluded from these educational opportunities due to their race. The Morrill Act worked by turning land expropriated from tribal nations into seed money for higher education (Lee & Ahtone, 2020). In all, nearly 11 million acres—an area larger than Massachusetts and Connecticut combined—were taken from nearly 250 tribes, bands, and communities through over 160 violence-backed "land cessions," a legal term for the giving up of territory (Lee & Ahtone, 2020). Most of the public flagship institutions were born through this effort.

While emancipation from chattel slavery was signed into proclamation in 1863, the exclusion of Black people from pursuing higher education lived on. The second Morrill Act of 1890, aimed at the former Confederate states, required states with racially segregated public higher-education systems to provide a land-grant institution for Black students whenever a land-grant institution was established and restricted for White students (Broady et al., 2017). The foundations of the "separate but equal" argument in education can be viewed through this second Morrill Act. Rather than stating that Black people should have access to the already established 1862 land grants, they were to be educated separately regardless of talent or potential. The act granted money instead of land and resulted in the establishment of several historically Black universities and colleges (Croft, 2019).

As this emancipation and educational liberation for Black people began, so did a system that would give Black and Brown communities disproportionate access: the carceral system. It is worth noting that the same year the second Morrill Act passed—1891—the United States Government established the prison system (Fleisher, 2001).Today, Black Americans are incarcerated in state prisons at nearly five times the rate of White Americans (Nellis, 2021).

It was not until 1901, almost 265 years after its original construction, that American higher education would be available to the masses. As open-admissions institutions, community colleges hold a unique position in the evolution of postsecondary education. For the first time in its history, higher education was being developed to serve as many people as possible. The development of community colleges generally mirrored that of American interest in higher education, as it was not guided by national policy. Communities would come together to found the local college, with the citizens laying the bricks and mortar and raising funds for their formation.

Despite segregation and other forms of division that support white supremacy, marginalized populations worked to establish their own havens for learning and teaching. As can be seen in Table 1, despite the economic, social, and political advantages of higher education being widely known, accessible higher education for all was not available until the founding of the first community college, 265 years after the creation of its exclusive Ivy League predecessors. Even as American society recognized the need for individuals to be educated, each incremental evolution of access to schooling had to reluctantly shed the culture of exclusion in which it was originally created. It is this appreciation for exclusion and elitism that fuels how universities are valued today, with the most selective holding the highest regard. It is through this maintained exclusion that CAOs must navigate college admission. Creating access for minority populations, particularly at historic institutions, could be seen as an act of rebellion in defiance of that history of exclusion.

Table 1

Timeline of Higher Education Construction

Institution Type (#)	Founded	Purpose
Ivy League (8)	New College (Harvard University), Established 1636	The first colonial college was founded specifically to prepare ministers.
Land-Grant Colleges (111)	University of Georgia, Established 1785	Focused on the agricultural and mechanical arts, without excluding other scientific and classical studies.
Catholic Colleges & Universities (226)	Georgetown University, Established 1789	Committed to making theology and philosophy central to undergraduate education, particularly the core curriculum.
Military Schools (18)	United States Military Academy (West Point), Established 1802	Originally founded as a school for the U.S. Corps of Engineers for the training of commissioned officers for the United States Army
Women's Colleges (50)	Georgia's Wesleyan College, Established 1836	Women's colleges prioritized the enrollment and higher education of women, focusing on creative arts, sociology, and literature.
Historically Black Colleges & Universities (101)	Cheyney University of Pennsylvania, Established 1837	Established with the principal mission of educating Black Americans.
Institutions of Confinement (4,518)	United States Penitentiary Leavenworth, Atlanta, & McNeil Island, Established 1891	The United States government established the federal prison system in 1891 with passage of the Three Prisons Act.
Community Colleges (1462)	Joliet Junior College, Established 1901	Designed to accommodate students who desired to remain within the community yet still pursue a college education.

Network of College Access Influences

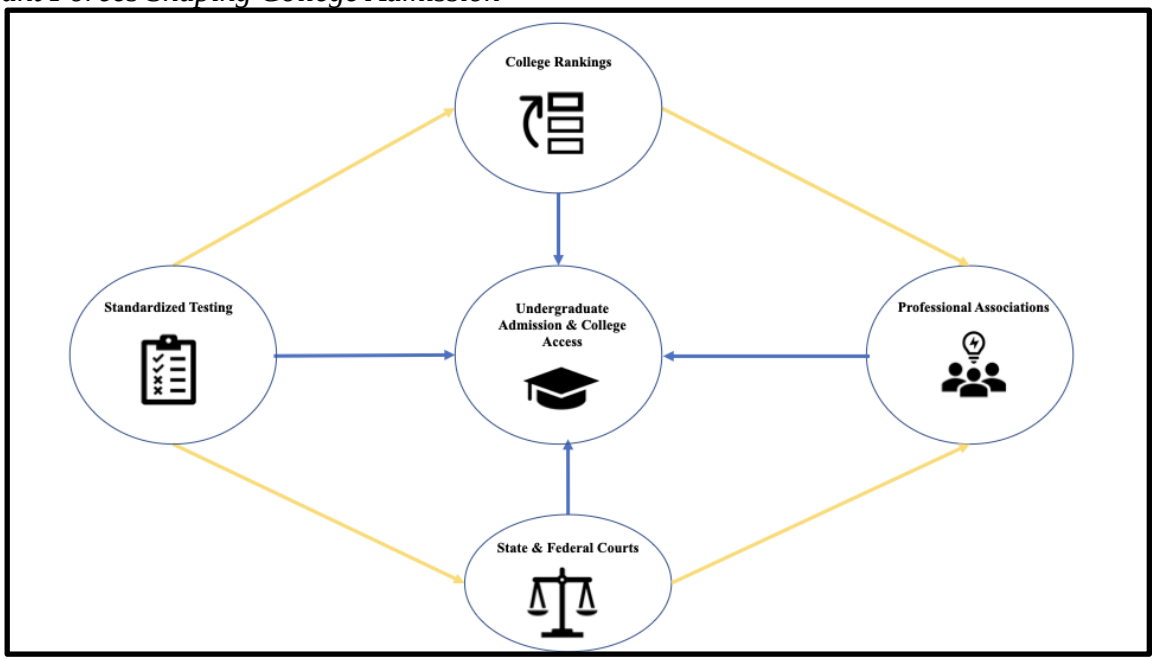
Using resource dependency theory (RDT) as a framework, I will explain in the following section how a network of organizations and associations has developed American society's

understanding of academic merit in the United States. Resource dependency theory (RDT) recognizes the influence of external factors on organizational behavior. RDT characterizes the corporation as an open system, dependent on contingencies in the external environment (Pfeffer & Salancik, 1978). Using RDT to understand how the entities in Figure 1 interact elucidates their interdependence. The impact of this interdependence has developed narrative and cultural definitions of prestige, merit, and belonging that are centered around sustaining whiteness and exclusivity. This system of oppression can only be addressed if it is recognized and understood. This section will examine four educational entities, their origins, their impacts on college admission, and their interdependence with another entity in the network. Undergirding these relationships are their historical, wide-ranging, and current individual impacts on American society's understanding of meritocracy and the implications of their interdependence on college-access practices and decision-making. Figure 1 shows the interactions between these significant forces shaping college admission and their influence on the practices and profession of college admission counselors.

Education in America, *en masse*, sits at the intersection of public good and commodity. Although education is not a constitutional right in the United States, higher education garners the interest of state legislators and politicians and is directly impacted by policies and state funding allocations. As a commodity, the selectivity of the nation's top 50 institutions has created industries around rankings and test preparation. As higher education in the United States evolved and garnered greater participation, associations and alliances formed to establish shared strategies, ethics, and values in college admissions. Understanding these associations and stakeholders reveals how the diverse institutions in the United States have adopted a common framework for understanding and executing college admission, defining prestige and quality, and defining merit for the public.

Figure 1

Significant Forces Shaping College Admission



Professional Associations

Professional associations in higher education and admission have been established over time to shape the identity of the industry. The Association of American Universities and the National Association of College Admission Counseling are membership organizations that have worked to establish expertise and develop industry standards and best practices that have shaped American higher education and the college-access industry respectively.

Founded in 1900, the Association of American Universities (AAU) comprises 71 leading research universities in North America, including two Canadian universities. Keeping membership small, the AAU became influential post–World War II through collaboration with the federal government, which led to the creation of influential entities like the National Science Foundation and the National Institutes of Health (Bloland, n.d.). AAU member universities collectively help shape policy for higher education, science, and innovation; promote best practices in undergraduate and graduate education; and strengthen the contributions of leading research universities to American society (AAU, n.d.). Today, AAU members earn a majority of the competitively awarded federal funding for research.

Established in 1937 as a small gathering of representatives from Midwestern colleges and universities, the National Association for College Admission Counseling (NACAC) has evolved into a diverse membership of over 25,000 individuals, institutions, and organizations. NACAC, along with its 23 affiliate organizations, serves admission-counseling professionals globally (NACAC, n.d.). The association acts as a valuable resource by facilitating large events connecting institutions with college-bound students, offering guides for ethical practices in admission, establishing professional recruitment rules, providing industry-expertise certification, and serving as a knowledge center on admission trends. NACAC's significant impact on the admission process led to a federal investigation by the U.S. Department of Justice in 2019, highlighting its influence on recruiting practices (U.S. Department of Justice, 2020). With members ranging from college admission officers to secondary counselors, NACAC continues to contribute best-practice information, industry-expertise certification, and guides for understanding the admission process and financial aid. It remains the largest and most influential community of practice in the college admission industry.

College Rankings and the Signals of Success

College guides have been providing information about the characteristics of different institutions for decades. *Barron's Profiles of American Colleges 2003–2004* (updated every other year), the *Fiske Guide to Colleges 2005*, *Peterson's Four-Year Colleges 2005*, and *The Insider's Guide to Colleges 2005* represent the 25th, 21st, 35th, and 31st editions, respectively, of these venerable publications. Jumping on the scene in 1983, *U.S. News & World Report* became the most popular of these guides due to its appearance of scientific objectivity and its ranking of the top 50 institutions in each category (Ehrenberg, 2005).

As a tool, *U.S. News & World Report* is widely used by students and parents worldwide to determine institutional prestige. The proportion of students who describe the ratings as being very important in their college choice process has increased by more than 50% since 1995 (Higher Education Research Institute, 2007). College rankings have the ability to influence attitudes in two specific ways. To begin with, students and parents often view the rankings as the "expert opinion" that helps to define institutional quality (McDonough et al., 1998). Additionally, consciously or subconsciously, students and parents often internalize the hierarchy presented in the rankings as a measurement of prestige and intellectual prowess, with the top

schools being the destination for the most promising students (Bastedo & Bowman, 2010). Consistently, the highest-ranked institutions are the most selective, with single-digit admit rates and admitted cohorts with incredibly high GPAs and averages on standardized tests.

With the rankings being widely used and held in high regard among the college-going population, researchers examined their impact on public perception and institutional behavior. Despite the lack of research on the indicators and their weights (Machung, 1998), Farrell and Van Der Werf (2007) were able to conclude that the weights assigned by *U.S. News & World Report* lack any empirical or theoretical basis. While institutions publicly claim not to care about the rankings, many respond to them through their admission practices. Some universities actively solicit applications from less qualified students in order to increase the number of applications, or reject top students if admissions professionals believe they want to go to better schools (Gnolek et al., 2014).

Analyzing rankings through the lens of RDT, it is possible to uncover just how dependent institutions and rankings are on one another and how admission environments are impacted by factors outside of the institution. Hillman et al. (2009) recognized that, although their contexts constrain them, managers can act to reduce environmental uncertainty and dependence. In this case, college admission leaders manipulate their applicant pool to appear more selective, to boost their profile in the college rankings; all in an attempt to be more attractive in an industry that values exclusion and selectivity. A 2011 report by NACAC described how institutions feel pressured by the *U.S. News* ranking process to invest in strategies to maintain or improve their rankings, which leads members to manipulate numbers or adopt targeted strategies merely to improve their rankings (NACAC, 2011). This response from CAOs shows just how impactful rankings are to their admission processes.

The focus on exclusivity and prestige is exacerbated by the rankings and the narrative they perpetuate. As institutional behaviors shift when responding to the perceived concept of quality embedded within the ranking process, Sponsler (2009) predicted that schools will become more like what is being measured, which will not always align with policy goals, particularly in the areas of equity and diversity. Given their influence on admission outcomes, resource allocation, and strategic planning, *U.S. News* rankings have a tangible impact on universities and the public (Gnolek et al., 2014). For CAOs, it is clear that exclusion relates to prominence in the ranking systems and that the public perception of rankings is so strong they must adjust strategies in order to appear favorable.

Standardized Testing in College Admission

Even in a post-COVID world, which saw many institutions ease testing requirements, standardized testing has persisted and has experienced a renaissance since the most recent SCOTUS decision as a major component of the college admission process. Understanding the origins of testing and its relationship with the earliest concepts of college admission can illuminate how ideas of intelligence and merit have been formed over time. Two testing agencies and three tests have persisted throughout the history of higher education as measures of intellectual ability that have become required for college entry.

The College Board is a national nonprofit membership association founded in 1900. Among its best-known programs are the SAT, the PSAT/NMSQT, and the Advanced Placement Program (AP). Less than 40 years after the abolishment of slavery, colleges and universities were evolving their admission requirements. Prior to the 1900s, colleges had used their own entrance exams along with an assessment of Latin or Greek, languages not commonly used throughout

society. In June, 1901, the College Board administered the first large-scale college admissions examination to 978 college-bound high-school seniors at 67 sites throughout the United States and two sites in Europe (Fuess, 1950). The education scene consisted of elite educational institutions in which only a small fraction of the nation's population participated (Barkan, 2010). It was about this time that prominent higher-education leaders began discussing common admissions tests.

In 1958, Dr. Everett Franklin Lindquist, a member of the College Board and professor at the University of Iowa, urged his colleagues to develop a test for the legions of less selective universities overwhelmed by the postwar expansion in applicants, a test of broad competencies, not of memorization, gauging mastery of curriculum, not God-given mental capacities. When his proposal was rejected by the College Board, Dr. Lindquist decided to create his own alternative (Wilgoren, 2002). The American College Testing Company administered the ACT test for undergraduate admissions for the first time in 1959.

Having begun as examination companies, both the College Board and ACT have a broad and deep impact on the college-going process in the United States. Illinois and Colorado have recently made the ACT test mandatory for all high-school juniors, and seven other states have adopted the company's eighth- and tenth-grade exams, which are modeled on the ACT test and intended to get younger students focused on, and ready for, college. In 2002, more than 1.1 million graduating seniors took the ACT test, not too far off the 1.27 million who took the SAT (Wilgoren, 2002).

Not surprisingly, the development of AP courses and tests also has origins in elitism. A 1952 report titled *General Education in School and College: A Committee Report by Members of the Faculties of Andover, Exeter, Lawrenceville, Harvard, Princeton, and Yale* stated: "We are well aware that there are many secondary schools and colleges to whom the principles and recommendations of the report will seem visionary and utterly unrelated to local realities" (Ballard, 1953, p. 2). *General Education in School and College* was, in fact, unashamedly elitist throughout. One key passage was brutally frank, in stating, "While we have tried to outline a program of study which would offer all students of college caliber a better education, we have been particularly concerned about the *superior student*. This concern is partly the result of our belief that standards can be pulled up from the top more easily than they can be pushed up from the bottom" (Ballard, 1953, p. 10).

The energy to expand AP courses was driven by schools, districts, and state legislators. In the late 1980s, South Carolina was among the first to pass legislation promoting AP participation, by requiring all of the state's high schools to offer AP courses and its colleges and universities to accept scores of 3 or better on AP exams. By 1994, Florida, Georgia, Indiana, Kentucky, North Carolina, Minnesota, South Carolina, and the District of Columbia paid all or part of students' AP examination fees. The effect was predictable. When states began to pay the costs of AP exams, the number of students taking the exams jumped by 60–80% (Rothschild, 1999). Today, AP courses and exams are offered in every state and many countries around the world. Scores are accepted by every major university in the United States; they signal advanced academic rigor and have even become required for acceptance into competitive majors.

Presently, the College Board is composed of more than 4,300 schools, colleges, universities, and other educational organizations. Each year, the College Board serves more than 3 million students and parents, 23,000 high schools, and 3,500 colleges through programs and services in college admissions, financial aid assistance, and providing teaching and learning tools for students and educators. Both the SAT and the ACT test are accepted by almost all U.S.

colleges. Some four-year colleges and open-admission colleges, including community colleges, don't require scores but may use them for placement or scholarships. Ranking systems, private tutoring, and other test-prep industries have developed business models around the measurements provided by these two companies, which have been largely unrivaled in the college admission industry.

Although there are approximately 5,300 universities across the country, the concepts of admissibility, access, and merit are influenced by a collection of agencies, organizations, and a select group of "elite" institutions. This analysis highlights how access to higher education has been granted; how it has evolved and now measures "college readiness"; and which influencers have created a national culture of how college access is understood and awarded. Whether it be the construction of the institutions and the admission process, the rankings that determine institutional value to consumers, or the metrics used to determine entry, American higher education and college admission have been designed for exclusion, with the greatest value assigned to the most selective. Even as institutions became more accessible, their admission practices and value propositions followed those of the most exclusive and rejective peers.

The Centrality of Privilege in College Admission

The interactions and relationships of these entities have come to dictate the practices in the admission profession, which reflect the ways our society defines merit and rewards exclusivity. With systems generating behaviors, research must focus on the outcomes these systems produce, particularly the college admission expectations and the racial disparities for students participating in STEM. Postsecondary institutions perpetuate whiteness by reifying discourses that privilege normative concepts of who students are and what successful students look like (Ledesma & Calderón, 2015). Whether it be standardized testing, master schedules, or the use of AP courses to determine rigor, these attributes have been centralized as the normal educational experience and therefore as an objective measure of success. More importantly, those who do not have these experiences are often considered to be not normal. Iverson (2007) explained that these assumptions allow for students who do not have these experiences or resources, particularly students of color, to be categorized as "disadvantaged" or underprepared and, therefore, defective. This logic also concludes that those who are admitted are "meritorious" and therefore better students.

Today, selective colleges and universities are working through two converging practices in college admission. The first practice involves an increased reliance on standardized test scores, and AP scores are central components used to determine whether to admit an applicant (Alon & Tienda, 2007). Even as the landscape of higher education emerges from a COVID-19 environment that saw many institutions move to test-optional or test-free evaluation processes, the use of testing in evaluation has persisted. This reliance, however, is problematic, as research has shown that the use of standardized tests as a basis of admission notably benefits those with more resources and power to influence how merit is defined while disadvantaging others (Alon & Tienda, 2007).

The second trend involves the growing societal pressure higher education is receiving to rapidly diversify. Colleges are being asked to increase the number of low-socioeconomic-status and underrepresented students on their campuses. This is being reflected on their websites and publications as well as in new college rankings that speak to the value of social mobility. Reports like *Social Mobility Elevators: An Analysis of Low-Income Student Enrollment and Outcomes at Four-Year Colleges and Universities* from Education Reform Now identified 614 four-year

colleges—out of an initial sample of about 1,900 institutions—that were able to meet three criteria:

- The majority of their Pell students graduated after six years rather than dropping out;
- Fewer than 6.9% (the national average for four-year schools) of their students had defaulted on their student loans within three years of entering repayment;
- At least 75% of the institutions' graduates had begun to pay down their federal student loans within five years of entering repayment. (Murphy, 2020)

Additionally, in 2021 for the first time ever, a public school was named Forbes America's Top College. In its explanation of the new rankings, Forbes made the claim,

It isn't enough to ask which schools give the best return on investment. It's also important to evaluate what kind of students they educate and whether they make themselves accessible to those who can't afford high sticker prices. Even if, like Harvard, they promise to pay full freight for the low-income applicants they accept, do they take enough disadvantaged students to make that promise meaningful? (Kreznar, 2021)Undergirding these two trends converging is the perceived tension between diversity and meritocracy. When underrepresented ethnic minority groups or underrepresented gender groups perform worse than others on criteria used to make important admissions or hiring decisions, the value of creating diverse school and work settings and the value of admitting and hiring the most qualified candidates seem to collide (Walton et al., 2013). With the rapid growth in the percentage of low-income and first-generation students participating in the college admissions process, the reliance on a metric that is not favorable nor truly predictive creates a bias in evaluation that disproportionately impacts the fastest-growing segments of the applicant pool.

As college admissions have become more selective, the conversations over who belongs and who does not have been debated in the education profession, the public, through research, and in the courts. As a result, the debate about who belongs at universities and how colleges should be assessing who belongs has influenced and been influenced by legal precedent. Much of the debate around belonging has focused on race and gender. As American society has gone through rapid shifts in the understanding of human rights and civil rights, these court cases were challenges to the expanded definition of "we" in "we the people." Table 2 contains a summary of impactful court decisions that have shaped the course of college admission over time.

Table 2

Timeline of Impactful Court Decisions on College Admission

U.S. Federal Court Case	Summary
Regents of the University of California v. Bakke (1978)	Racial admission quota system for UC Davis Medical School was deemed unconstitutional
United States v. Virginia et al. (Virginia Military Institute Admission Policy) (1996)	Single-sex admissions ruled unconstitutional
Grutter v. Bollinger (2003) Gratz v. Bollinger (2003)	Affirmed right to consider race as a part of the holistic review, but use of racial quotas in admission ruled unconstitutional

Fisher v. University of Texas (2013)	Supreme Court: Schools should be allowed to consider race in admission as one part of a broader affirmative-action plan to promote diversity

Table 2 (continued)
Timeline of Impactful Court Decisions on College Admission

U.S. Federal Court Case	Summary
Students for Fair Admissions (SFFA) v. University of North Carolina at Chapel Hill (2021)	Federal judge upholds UNC's use of race-conscious admissions program to enhance student diversity
SFFA v. Harvard College and University of North Carolina at Chapel Hill (2023)	Supreme Court: Bans explicit consideration of race in evaluation of applicants at all US Colleges and Universities.

In all of these court cases, the value of diversity in education was challenged by White elitism and the belief that the admission of students of color to elite colleges could not be achieved without cheating. These court cases also elucidate one of the tenets of critical race theory, which speaks to the permanence of racism and the belief that racism is normal. This permanence persists, as affirmative action in college admission has been banned during the course of writing this dissertation by a Supreme Court decision in July of 2023. In the context of college access, the need to fight for marginalized communities to participate in higher education amplifies the argument that institutions were not built to serve everyone but just a privileged few. It is with this ethos of exclusivity, centering whiteness, and accepted version of merit that the college admission process, and in turn, American society's belief about who belongs in college, has been built. Generation after generation of promoting and protecting these understandings have clashed with the demographic shifts in the United States. While there has been great change, the most exclusive spaces still look very much as their founders intended: White and male. This is most true when examining the STEM disciplines. Chapter 3 will examine the interaction between a diversifying student body that has an interest in the most selective places and the forces that aim to continue with their exclusive practices.

Summary

Exploring the genealogy and history of college admission is critical to understanding the mental models and entities in which the profession currently sits. This chapter explained the history of exclusion and the ecosystem of professional standards, media values, and legal action that historically and continues to support the value of exclusion in college admission. Similar to the Ivy League schools, which are still the most selective and exclusive institutions, the STEM majors are the most selective and most exclusive majors for college applicants. The next chapter explores the factors that contribute to underrepresentation in STEM majors, the efforts to resist the system and rebalance representation, and the impact of educators on student participation in STEM.

Chapter 3: The Students Left Behind: Disparities of Black and Brown Opportunity to Participate in STEM Education

In order to understand the experiences that result in the underrepresentation of Black and Latinx college students in STEM, we must examine the factors that contribute to their decisions earlier in their academic careers. As an educational leader for equity and democracy, I find it is also important to understand what the literature reveals about the efforts that have been taken to address this underrepresentation and their impact. We cannot create a new educational system for all with a lack of understanding of what cripples the current system (Love, 2019). If systems are built to generate behavior, then the phenomenon of underrepresentation in STEM is not an accident and is in fact by design. Through the acknowledgment of the disparate K–12 experiences of Black and Latinx students engaging in STEM, this analysis of the literature aims to challenge admission practitioners to develop metrics that are reflective of these disparities. It also challenges K–12 practitioners to lean into proven constructions of educational experiences that support students' desire to pursue and be successful in STEM.

This literature review is organized into two sections. The first section explains the theoretical framework that guides the research throughout this dissertation. The second section explores the research relevant to STEM underrepresentation among students of color. This research falls into three domains. The first domain includes the knowledge base that characterizes the underrepresentation of students of color in STEM, and the factors that contribute to their exclusion in these disciplines. The second domain includes research on efforts and initiatives to encourage and affirm the participation of underrepresented students in STEM. The third and final domain explores the roles of educators and counselors in cultivating inclusion and equity to diversify the STEM pipeline. I chose these domains to contextualize institutional requirements within the landscape that Black and Latinx students interested in STEM are experiencing broadly. I ask admission officers and practitioners to reflect on how to develop processes that are considerate of these disparate experiences for just access to STEM majors in college.

Theoretical Framework

As the student demographics in the nation are shifting more quickly than the major social systems these students are inheriting, the misalignment between the experiences of the growing population and the ways that admission professionals and university faculty define "standard experiences" becomes an incredible liability, with Black, Latinx, and low-income communities paying an incredibly high price. Making meaningful connections within and between these systems and the harm they cause allows CAOs to then determine the best interventions that can produce different results.

Before examining the relevant literature, it is important to understand the theoretical concepts that inform my research. Maxwell (2013) described conceptual frameworks as "the system concepts, assumptions, expectations, beliefs, and theories that support or inform your research" (p.39). I use *critical race theory in education* and *anti-deficit theory* as primary frameworks to examine the experiences of Black and Brown scholars as they navigate the STEM admission process. I weave these theories together with *affirmative meritocracy* to examine how CAOs characterize those experiences and provide access to STEM majors.

Critical Race Theory (CRT) in Education

Education is a system that is too big to be dismantled and rebuilt, and so it must be rethought, retooled, and reimagined. However, in order to change a system, actors must see the system in its entirety. In order to see the system of college admission, I employ Ledesma and Calderón's (2015) *Critical Race Theory in Education*. Adopting tenets from the original critical race frameworks, the foundational *Critical Race Theory in Education* relied on four utilities: 1) challenging notions of race-neutrality, objectivity, and ahistoricism; 2) interrogating how majoritarian structures have historically shaped and framed educational access and opportunity for historically underrepresented populations; 3) exposing how the prevalence of whiteness and white supremacy, frequently in the guise of color blindness, covertly and overtly shapes the culture of higher education; and 4) demonstrating how postsecondary institutions perpetuate whiteness by reifying discourses that privilege normative conception of who students are and what successful students look like. In this study, I utilize CRT as a conceptual framework to examine the impact of how university faculty and admission professionals define merit in the college admission process at public universities based on the experiences of the privileged versus what is commonly available for a non-privileged growing demographic.

Anti-Deficit Framework

In order to address a research void related to minority students who graduate from college and successfully complete STEM education programs, Harper (2010) developed an achievement framework that aims to shift the narrative away from deficit perspectives on URM student accomplishments. The anti-deficit framework focuses on understanding how URM students actually achieved and overcame disadvantages. Harper (2010) posited that those who endeavor to improve student success in STEM would learn much by inviting those who have been successful to offer explanatory insights into their success. In this study, the anti-deficit framework can enhance CRT in education by orienting the line of inquiry to identify liberatory practices of CAOs who are succeeding in providing access despite the barriers and pressures they face to uphold oppressive practices.

Affirmative Meritocracy

Affirmative meritocracy suggests that most tools to measure merit are biased or unfair, and in order to use them, analysts must account for the disproportionate outcomes provided by their assessments (Walton et. al., 2013). While much can be said about the ways in which race, class, and gender skew performance scores in a variety of metrics, the framework of affirmative meritocracy allows CAOs to challenge the tools American institutions use to define merit (Walton et. al., 2013). In this study, affirmative meritocracy gives a framework to describe the actions of practitioners who recognize that the educational experiences in their applicant pool are so varied that in order to ensure merit is in their process, the evaluation tools must be calibrated to those varied experiences rather than a single prototype for merit.

Organizing Framework for Literature Review

To look at high-school factors that affect URM students' persistence in STEM education, I began by organizing the literature through an adaptation of Astin's (1993) I-E-O model for understanding underrepresentation in higher education by considering the *input* and *environment* to explain the *output* variables related to student representation and student major choice. The term *input* refers to the characteristics of the student and the representation in STEM;

environment refers to the high-school environment, programs, faculty, curriculum, and educational experiences to which the student is exposed; and *outcomes* refers to the student's choices and actions after exposure to the environment (p. 7). Examining educational systems, in this analysis, I focus specifically on the environment and its impact on the outcomes of student participation as I seek to understand the big picture around racism and the STEM education pipeline. Addressing the system rather than the participant allows for greater critique on the navigated systems and the entities that constructed it.

Braiding the I-E-O model with Harper's (2010) anti-deficit framework makes the central equity dilemma more visible by highlighting the resources and experiences that the research has found to be conducive to student success and contrasting that with who has access to those same resources and experiences. The anti-deficit framework allows me to take a systems approach to consider how educators' mental models around Black and Latinx engagement in STEM affect students' current reality and future participation in the discipline. As this literature builds, it is my intention to focus on excavating interventions that fix the system rather than the individual charged to navigate it. If all students have potential, then it is vital to critically assess the experience and opportunities educators expose them to and the outcomes created by that exposure.

Scope of Literature Analysis

Baird et al. (2016) concluded that although URM students have shown evidence of a strong preference for or interest in STEM fields, they are less likely to graduate with STEM majors. While the high-school graduation rates for Black and Latinx students in 2017 was 78% and 80% respectively (U.S. Department of Education, 2018), the college enrollment rate for Black and Latinx students was only 36% (U.S. Department of Commerce, 2018). The literature points to experiences at both the high-school and college level as contributing factors to the lack of persistence in pursuing STEM for Black and Latinx scholars.

On the college end, the research suggests that organizational characteristics of colleges affect the likelihood of college STEM success for URM students (Arcidiacono et al., 2013; Bonous-Hammarth, 2000; Chang et al., 2008; Crisp et al., 2009; Engberg & Wolniak, 2013; Espinosa, 2011; Nicholls et al., 2007). These scholars argued that the representation of URM students in STEM is related to the selectivity and type of institutions that students attend. Racial isolation in college has a negative relationship with performance. Black and Latinx students often feel invisible in, alienated from, and unwelcome in STEM educational settings (Strayhorn et al., 2013). These challenges lead to URM students who do select STEM degrees taking more time completing their STEM degrees than their White and Asian peers, a convergence that sets the scene for further underrepresentation in physical sciences, engineering, and computer science (Whalen & Shelley, 2010). While these impacts are no doubt significant, for the purpose of this literature analysis, I narrowly focus on what happens in high school, while acknowledging there is more to be considered on the college side as well. The subsequent review of the literature will discuss the contributing factors to current URM representation in STEM.

Contributing Factors to URM Underrepresentation in STEM

The disparities in URM participation in the sciences is a phenomenon that has been studied and researched for decades. In 1977, Blacks were disproportionately underrepresented among doctoral-degree recipients in the natural sciences, with 1.3% of conferrals going to African Americans compared with 12% of African Americans in the U.S. population (National

Science Board, 2000). Since then, there have been a number of studies on the causes of this underrepresentation, its contributing factors, and the implications for the STEM industry. However, 25 years after the 1977 report, the National Science Board reported Blacks were still disproportionately underrepresented among doctoral-degree recipients in the natural sciences, with only 2.4% of conferrals in 1997 compared to the 12.8% of African Americans in the U.S. population (Lewis, 2003). Similar trends can be seen in Latinx representation, despite their growing share of the overall U.S. population. Today, Black and Latinx individuals constitute 30% of the U.S. population. By 2050, these groups will account for more than 40% of the U.S. population (National Action Council for Minorities in Engineering, 2013). Nonetheless, there is a significant underrepresentation of Black and Latinx students in STEM majors in college (National Science Foundation [NSF], 2016). The disproportionality of minority students in STEM majors foreshadows their representation in the professional STEM industry. The factors that have emerged from the literature that contribute to the underrepresentation can be arranged in two main themes: (1) the availability of STEM coursework and supports, and (2) inequitable participation in STEM coursework. In this literature review, I use research to analyze both of these factors while also recognizing the role that educators and administrators play in either perpetuating or dismantling the inequities we see in representation in the STEM discipline.

Disparities in Availability of STEM Coursework and Supports

Recurring in the research is the finding that students in low-income, majority-minority schools have less access than students in other schools to computers and to staff who coordinate their use in instruction, to science laboratories, and to other common science-related facilities and equipment. Low-income Black and Latinx students enrolled in secondary schools where they are the majority have less extensive and less demanding science and mathematics programs available to them. They also have fewer opportunities to take the critical gatekeeping courses that prepare them for science and mathematics study after high school—algebra and geometry in junior high school and calculus in senior high school (Oakes & Guiton, 1995). The accumulating evidence concerning the importance of science and mathematics coursework in high school is overwhelming (Tyson et al., 2007). In their study on STEM pathways, Tyson et al. (2007) argued the importance of physics and calculus high-school courses and their correlation to success in STEM majors.

The literature on students who choose and persist in STEM majors emphasizes the importance of having adequate secondary-school academic preparation, prior experience with rigorous math and science, and a history of taking high levels of math and science courses such as physics (Bottia et al., 2015; Chang et al., 2014; Crisp et al., 2009; Hughes et al., 2013; Ma, 2009; Nicholls et al., 2007; Strayhorn, 2015; Wang, 2013a, 2013b; You, 2013). Time spent studying is also emphasized as a measure of the likelihood of URM students declaring and persisting in STEM (Bottia et al., 2021). In fact, a significant amount of studies support the claim that structural factors related to the inferior type of K–12 schooling URM students receive undermine their likelihood of succeeding in college STEM majors (Bottia et al., 2021).

The literature specifically highlights the role of the high-school teaching environment, including the diversity of teachers (Moller et al., 2014) and the demographic and academic characteristics of the high schools students attend. To this end, studies have shown that the likelihood of URM students going into a STEM major increases if they attend racially and socioeconomically diverse high schools (Bottia et al., 2018). A student's interest in and ability to major in STEM disciplines in college is primarily seeded in their exposure to STEM courses in

high school. Past studies have found that high-school physics is the chief STEM pathway (Tyson et al., 2007). Taking physics during high school is an important determining factor in students choosing to pursue a STEM major in college, particularly for young women (Bottia et al., 2015). Experience in these courses is foundational to a student's readiness to engage in STEM majors in college.

Disparities in Availability of AP Rigor. As the value of a STEM college degree has continued to rise, so has the appeal of AP classes. The AP program offers an opportunity for students to earn college credit and develop college-ready skills in high school (Kolluri, 2018). Soon after its creation, the designers of the AP program asserted that the program was based on the presumption that "all students are not created equal" (Dudley, 1958 as cited in Schneider, 2009, p. 817). Over time, however, the AP program has evolved fairly consistently in the direction of greater access (Lacy, 2010; Valentine, 1987). In the 1990s, the federal government took an interest in the program, directing funding toward low-income communities to encourage participation in APs (Klopfenstein, 2004). The percentage of students of color in the program grew substantially from 12% in 1979 to 31% in 2002 (Schneider, 2009). However, despite the expansion of participation in the AP program, the nature of the participation by race, ethnicity, and class elucidates a disturbing trend.

The literature illuminates the disparities in AP course offerings between schools. Zarate and Pachon (2006) found that greater percentages of Black and Latinx students and a greater percentage of low-income students are both negatively correlated with AP course offerings at the high school. In their research, they found that schools in California (1,000–1,500 students) serving less than 10% African American and Latinx population offer more than 1.5 times as many AP courses as schools serving 75% to 100% African American and Latinx students. Solórzano and Ornelas (2004) found that the 50 California schools with the most AP offerings served an average of 21% Latinx and African American students, well under their 46% overall enrollment in California high schools at the time of the study.

While urban and rural schools have struggled to match the AP offerings of the suburban and wealthy districts, another way to level the AP enrollment gap is to expand the participation of underrepresented students at predominantly White schools. Predominantly White high schools have a long history of inequitable access to classroom rigor for their Black and Latinx students (Kolluri, 2018). While segregation may be more pronounced between schools than within them, students continue to be sorted within schools along lines of race, ethnicity, and poverty status (Clotfelter et al., 2002; Kalogrides & Loeb, 2013).

These findings indicate the importance of educational context and more specifically course preparation in high school and available pathways through math and science to a student's ability to pursue STEM. In addition to the availability of STEM courses among schools, the research highlights the disparate levels of participation in STEM courses within schools as well. Uncovering the factors that play a role in the disparate participation in STEM high-school curricula is necessary to understand the lack of engagement in STEM major choices in college.

Inequitable Participation in STEM Coursework

Despite efforts to increase access to AP courses, Theokas and Saaris (2013) found that gaps in participation remain significant by socioeconomic status. In their report, the scholars found that low-income students enroll in AP classes at less than a third of the rate of their middle-income and wealthy peers, even when they all attend schools offering multiple AP

options. Using a different measure of socioeconomic status, Malkus (2016) used National Center for Educational Statistics data to report that students whose parents graduated from college are nearly twice as likely to participate in AP courses as students whose parents did not graduate from high school. Multiple factors are theorized to affect students' participation in STEM coursework. Here, two themes are explored: (1) AP participation inequities; and (2) the effect of tracking on student STEM participation in high school.

AP Participation Inequities. The gap in participation for Black and Latinx students in AP courses can be seen in the numbers. In "The 10th AP Annual Report to the Nation," the College Board reported an underrepresentation of Black students, noting they made up 9.2% of exam takers but 14.5% of the nationwide graduating class (College Board, 2014). In the same report, Latinx students were found to be proportionally represented in AP, making up 18.8% of both graduates and AP exam takers in the United States.

When the data is disaggregated by AP subject area, however, the inequity is further illuminated. In 2014, the College Board found that Black students were underrepresented in every AP subject and Latinx students were underrepresented in all AP courses other than Spanish Language, Spanish Literature, and Italian Language and Culture (College Board, 2014). The enrollment inequities were particularly stark in STEM-related courses—those noted to impact students' future engagement with STEM majors. African American students made up 2.9% and Latinx students 8.3% of AP exam takers in Calculus BC and only 2.8% and 8.7% respectively of Physics C: Mechanics test takers. Particularly concerning is the unequal participation in AP Computer Science courses, where combined African American and Latinx students only made up 31.2% of AP Computer Science test takers (College Board, 2014). Access to the proper STEM curriculum in high school can be foundational to ultimately earning a STEM degree (Bottia et al., 2015).

Intersectional identity markers influence student participation rates. For instance, socioeconomic status (SES) is an important influence on the likelihood of Black students electing to major in STEM. As family SES increases, Black students are more likely to major in STEM (Niu, 2017). The inverse has also been found in the literature. URM students' lack of financial, social, and cultural capital often manifests as weak information about and academic preparation for STEM courses, which limits their chances of and persistence in STEM (Russell & Atwater, 2005). The ways in which schools are organized and zoned reinforce these dynamics.

Availability of and participation in STEM rigor are designed by educators and are critical components to the educational experiences students navigate. Yet, the decisions that ultimately impact student course participation often begin long before high school, thanks in great part to academic tracking among a large cross-section of American schools. Structures such as tracking, and their influence on teacher beliefs and practices, further affect student participation. While the literature highlights the importance of strong STEM pathways and the ability to participate in those pathways to a student deciding to participate in STEM in college, to understand how those pathways are constructed we must look at academic tracking and its influence on student engagement with STEM.

Impact of Tracking. *Tracking* refers to the practice of dividing students by ability or achievement. Schools may track students by placing them into different classrooms based on achievement, which is the typical practice in countries such as the United States or Canada. Tracking can also stream students into different schools, with either vocational or academic

emphases. Sociologists of education have found that assessments of student academic ability and subsequent placement of students into different tracks or ability-grouped classes often parallel race and social-class differences (Carbonaro, 2005; Lucas, 2001; Mickelson, 2001; Oakes, 2005). As such, although the decisions are usually well-intentioned, considerable evidence suggests that tracking, especially in high school, fails to increase learning generally, and has the unfortunate consequence of widening the achievement gaps between students judged to be more and less able. Jeannie Oakes serves as the seminal researcher on academic tracking in schools, with thousands of citations to her credit. In her research, Oakes (1990) found that in schools with large concentrations of low-income and URM students, disproportionate percentages of teachers judge their students to have low ability in science and mathematics. Further evidencing this concerning impact of teacher beliefs on student outcomes, in schools with racially mixed student bodies, the proportion of classes judged to be high-ability diminishes as racially minoritized enrollment increases, with students of color more likely than their White peers to be placed in low-track classes.

Compounding this issue, Tyson (2011) argued that elementary-school teachers and administrators frequently promote racialized notions of "giftedness" that influence Black students to lack confidence in their intelligence and to subsequently enroll in fewer AP courses in high school. Racial assumptions about intelligence and racialized tracking patterns become mutually reinforcing when Black students who may be capable of AP work shy away from predominantly White AP classes that make them uncomfortable (Kolluri, 2018).

The persistence of gaps in AP enrollment and the bias surrounding tracking highlight particular theoretical assumptions about social reproduction in educational settings. These processes suggest a tendency toward effectively maintaining inequality. *Effectively maintained inequality* theorizes that as participation in particular levels of school approaches saturation—in this case increased AP access during secondary education—dominant groups maintain inequality by ensuring exclusive access to distinctions within the saturated levels (Lucas, 2001). Simply put, as participation in AP courses grew among URM and low-income students, advantaged groups and highly resourced high schools provided opportunities for students to pursue an increasing number of distinctions to maintain their competitive edge. Finding new ways to create differentiation of access to AP class offerings, these high-school environments facilitate the gaps in AP enrollment to persist to support the value of exclusive environments for dominant cultures and the need to establish cultural or academic capital that others cannot access.

The minds and attitudes of prospective STEM scholars are impacted by a variety of factors that ultimately contribute to their actual pursuit of STEM. The literature gives specific mention to URM pre-college and college attitudes, education and occupational aspirations, STEM identity, sense of belonging, self-efficacy, confidence, enjoyment of math and science, and engagement as some of the most common psychosocial constructs associated with Black and Latinx students' STEM outcomes (Bottia et al., 2015; Chang et al., 2008; Espinosa, 2011; Moller et al., 2014; Museus et al., 2011; Strayhorn, 2015; Tyler, 2010; Toven-Lindsey et al., 2015; Wang, 2013a).

The literature shows that URM students tend to have lower levels of STEM identity, self-efficacy, and confidence as science learners (Chang et al., 2008; Chang et al., 2014; Nicholls et al., 2007; Museus et al., 2011; Sahin et al., 2018; Strayhorn, 2015; Toven-Lindsey et al., 2015; Tyler, 2010; Wang, 2013b; Xie et al., 2015); and lower levels of other psychosocial characteristics (such as a sense of belonging) that are positively associated with success in STEM. Most importantly, the literature shows that the lack of sense of belonging in STEM for

women of color, Black and Latinx men, and URM students in general contributes to why they are unsuccessful in their pursuit of college STEM degrees (Burt et al., 2018; Cabrera, 2014; Ceglie & Settlage, 2014; Rainey et al., 2018; Museus et al., 2011; Russell & Atwater, 2005; Strayhorn et al., 2013; Xie et al., 2015).

Addressing the underrepresentation of students of color in STEM majors requires admission professionals to contend with multiple factors that contribute to the issue at hand, including inequitable course availability and, subsequently, inequitable course participation. The research indicates the benefits of participating in rigorous and resourced environments for students interested in STEM. Additionally, the research illuminates the disparities of access and participation in academically rigorous and resourced environments for Black and Latinx students. In the midst of these disparities, there have been liberating initiatives that have proven to increase engagement and the likelihood of participating in STEM for students of color. Next, I turn my attention to efforts that have been successful in balancing STEM representation.

Efforts to Balance the Representation in STEM

The STEM education movement and its goal of increasing the number of students selecting STEM majors and careers has gained dramatic momentum over the past decade. This is reflected not only in the proliferation of local and state STEM programs that now exist across the country, both in schools and out, but also in numerous federal reports and policies, the federal budget, and initiatives like the White House's Educate to Innovate (National Research Council, 2011, 2013; National Academy of Sciences et al., 2005; President's Council of Advisors in Science and Technology [PCAST], 2010). Fueled by the booming tech-industry sector and the baseline education needed to participate, a workforce shortage is looming. This shortage has been characterized as the result of a "leaky pipeline" (Alper, 1993; Leboy, 2008; Valla & Ceci, 2014) through which students, especially women and other underrepresented groups, leave STEM fields. According to the literature, somewhere in the course of their pre-K–16 education, these groups either lose interest in STEM-related learning, lose confidence in their abilities to perform in these fields (Wells et al., 2007; Unfried et al., 2014), or feel that the "STEM culture" is not welcoming to them (Good et al., 2012; Smith et al., 2013), resulting in large numbers of students opting out of (or not opting into) STEM majors and careers (e.g., Blickenstaff, 2006; Wickware, 1997).

A 2010 report from PCAST included an analysis of the demographic shifts and the rise of the STEM industry, and made the case for reframing our workforce challenges. Rather than *selecting* STEM talent, PCAST suggested *developing* STEM talent:

> [S]tudies suggest that achieving expertise is less a matter of innate talent than of having the opportunity and motivation to dedicate oneself to the study of a subject in a productive, intellectual way—and for sufficient time—to enable the brain development needed to think like a scientist, mathematician, or engineer. This has important implications for STEM education; it underscores the need to motivate students for long-term study of STEM, and points to the potential for many more students to excel in STEM (PCAST, 2010).

To understand the efforts that have been studied to date, I focus on two specific themes: changes to the educational context and high-quality, expanded learning opportunities. Using Harper's (2010) anti-deficit framework allows me to explore and better understand the enablers

of URM student achievement in STEM. Instead of relying on existing theories and conceptual models to repeatedly examine deficits, the following research attempts to discover how students of color have managed to succeed in STEM.

Establishing Affirming Educational Context

Educational contexts refers to conditions of the high-school environment that directly or indirectly influence students' chance of choosing and persisting in a STEM major. In their study, Bottia et al. (2015) proposed that students' intent to major in STEM is affected by a set of high-school learning experiences that may be inspirational, reinforcing, or preparatory. Their results concurred with other studies that showed that early exposure to STEM-related courses and higher quantity and quality of STEM-related courses are linked to higher STEM course-taking in college and to students' decision to pursue a STEM-related degree (Engberg & Wolniak, 2013; Hoepner, 2010; Lee & Judy, 2011; Newton et al., 2011; Wang, 2013b).

There have been several meta-analyses that suggested that greater resources do in fact lead to higher test scores (Card & Krueger, 1996). The authors of these studies argued that the literature contains too many positive estimates of the effect of resources on test scores to have occurred by chance, if resources truly do not matter (Glass & Smith, 1978; McGiverin et al., 1989; Hedges & Stock, 1983). Additionally, there is a body of literature that shifts the attention away from test scores and focuses instead on how school resources affect students' educational attainment and earnings. Studying the impact of school resources on long-term outcomes like educational attainment and earnings is critical because test scores are an imperfect measure of the value of school outputs (Card & Krueger, 1996). Upon reviewing the literature, the strategy that resonated with me as most impactful to increase URM participation in STEM involved a strong critique of the high-school curriculum and how it is navigated.

Curriculum Considerations. Crisp et al. (2009) conducted an analysis of pre-college experiences that influenced STEM major selection. They found that students' STEM-related learning experiences during high school are associated with students majoring in STEM. In their longitudinal study, Bottia et al. (2015) found taking physics as the strongest variable to predict a student's odds of declaring a STEM major in college. Their research also found that attending a school with a math-and-science-focused program is positively correlated with a student's intent to major in STEM.

The accumulating evidence concerning the importance of science and math coursework in high school is abundant. High-level coursework in these areas is important for student learning and leads to significant outcomes, including college and graduation (Schneider et al., 1998). Science and mathematics course-taking is a key component of the pathway to a STEM career. Madigan (1997) showed that students who took more rigorous science courses had greater increases in science proficiency, regardless of their initial proficiency levels, and that the rigor of science courses was more important than the number of science courses for increasing proficiency. Students who took physics had the largest increases, and students who took chemistry had larger increases than those who took neither physics nor chemistry. After employing descriptive statistics and logistic regression to determine the relationship between race, class, and gender and high-school science and mathematics course-taking achievement, Tyson et al. (2007) found that enrollment and attainment in physics and calculus is particularly important for all students with respect to obtaining a STEM degree. This is particularly important for students of color. Tyson et al. (2007) found that African American students with higher-level

coursework preparation are just as likely to obtain STEM degrees as their White peers. Similarly, Latinx students with advanced-level course preparation are also more likely than White students to persist to obtain a STEM degree.

Expanded Learning Opportunities

Studies also highlight the importance of expanded and informal learning opportunities as a means toward increasing URM student representation in STEM degrees. Chang et al. (2014) concluded that student participation in a departmental club or an academic club can have significant impact on students pursuing STEM degrees. There is strong evidence in the literature that from early childhood through the college graduation, informal learning such as co-curricular activities and STEM-themed summer camps contribute to the likelihood of URM students declaring and persisting in STEM majors. Strayhorn (2015) argued that attending summer camps during childhood helps increase Black students' success in STEM fields specifically. Russell and Atwater (2005) spoke to the absence of informal STEM learning opportunities like participation in science fairs or pre-college science research programs for Black and Latinx students as a limitation on their likelihood to major in and persist in STEM. It is clear that not only the academic offerings are important, but the impact of the environment for learning and identity development as a scholar is critical to URM students.

Scholars and researchers have identified pre-college programs as institutional vehicles to boost STEM interest (Burgin et al., 2015; Constan & Spicer, 2015). University-run STEM programs for high schoolers have been around since the 1950s (Cooley & Bassett, 1961; Niemann et al., 2004). The National Science Foundation funded programs aimed to provide students with STEM training beyond what was available in high-school classes to promote interest in STEM (Cooley & Bassett, 1961). Many of these programs were established in response to Soviet advancement in space exploration and the launch of Sputnik. Decades later, science education support came to be seen as a tool to generate economic development, and investments were made accordingly (Katzenmeyer & Lawrenz, 2006). While there are many STEM-focused expanded learning opportunities, I focus here on two of the most well-researched: (1) summer programs; and (2) integrative learning.

STEM Summer Programs. Summer programs generally last from two to eight weeks and exist nationwide. Astin (1971) studied an NSF outreach program called the Student Science Training Program (SSTP). This program aimed to foster interest in the science field by exposing talented high-school students to research and teaching at the postsecondary level. The SSTP was typically offered in the summer after junior year and featured a combination of hands-on research experience and science subject instruction. Common aims of summer programs are to boost academic skills, raise confidence, provide exposure to STEM work, foster favorable STEM attitudes, and promote STEM interests (Kitchen et al., 2018). These are accomplished through a range of activities, including lectures, meeting STEM professionals, and working on STEM projects.

Upon reviewing the literature, studies that examined the impact of high-school STEM programs on students' knowledge, skills, and preparation are the most common. Students have reported improved math study skills and heightened awareness of education planning and personal learning styles as a result of program participation (Enriquez, 2010). In addition, the literature overwhelmingly supports that students who participated in a summer STEM program also tended to feel better prepared for STEM coursework or college-level courses (Exstrom &

Mosher, 2000; Markowitz, 2004; Rohrbaugh & Corces, 2011). This is particularly important for URM students, as summer programs provide opportunities for students to use laboratory equipment that may not be available in their high schools (Markowitz, 2004). The evidence in the literature suggests that STEM summer program participants are likely to enroll in STEM-related majors during college (Hurtado et al., 2009; Kabacoff et al., 2013). For example, for the first three years of the QUEST program at Mississippi State University, 81% of students went on to enroll at the institution, and 73% enrolled at the College of Engineering (Taylor & Green, 2005). Momoh (2014) added that 90% of students who participated in the Pre-College for Engineering Systems program at Howard University ultimately majored in electrical engineering or another related STEM field. While the evidence is apparent in the literature around the effectiveness of STEM summer programs, it must be noted that they, too, have disparities in access. Cost and competition for access to summer programs are barriers that continue to favor those with financial and social resources.

Integrative Learning. Numerous studies have spoken to the efficacy of various programs that aim to renew student enthusiasm, interest, and knowledge in the sciences (Bottia et al., 2015). Many reinforcing experiences occur outside the classroom. They include outreach programs, extracurricular activities, school clubs, and science enrichment programs (Atwater et al., 1999; Gibson & Chase, 2002; Howe, 2009; Knox et al., 2003). The literature offers strong evidence that from early childhood through the college years, informal learning such as co-curricular activities and STEM-themed summer camps has an important role in fostering URM students' odds of success in college STEM. Attending summer camps during childhood helps increase Black students' success in STEM fields (Strayhorn, 2015). While K–12 institutions are incredibly impactful in addressing the nation's STEM education challenges, scholars and policymakers have explicitly recognized that it is necessary for universities and colleges to partner with K–12 counterparts to strengthen and diversify STEM pathways to improve STEM education overall (Constan & Spicer, 2015; Eeds et al., 2014; Engberg & Wolniak, 2013; Kennedy & Odell, 2014; PCAST, 2012).

Navigating STEM Education: The Role of Educators and Counselors in Cultivating Diversity and Equity

While studies certainly highlight the impact of the educational context, there is also an argument made through the literature on the importance of *key professionals,* such as college counselors and teachers who share key student identity markers such as race. Teachers and counselors play an important role in students' postsecondary planning processes. In this section, I explore (1) effective pedagogical approaches that may increase URM participation in STEM; (2) the specific importance of faculty of color in high-school STEM offerings; and (3) the role of college counselors.

Effective Pedagogical Approaches

Curriculum design (Strayhorn et al., 2013), the meaningfulness of the assignments given students' lived experiences (Barker et al., 2014), and certain instructional techniques, like active learning strategies (Rainey et al., 2018; Russell & Atwater, 2005), all show up in the literature as critical components of pedagogy that have a significant impact on STEM persistence for URM students. In a study of successful teachers in K–12, Kohli and Pizarro (2016) examined the experiences of community-oriented teaching. *Community-oriented teaching* describes teachers

who feel relationality and relational accountability to their communities. This approach is grounded in a teacher's perceived responsibility not just to teach their students but to serve them as well. These teachers, many of whom are of color, find themselves in conflict with the ethos of traditional Eurocentric education. Particularly, although their ways of being and knowing provide them with insights into engaging students of color, the culture of their schools does not recognize critical or community-based approaches to working with students of color (Kohli & Pizarro, 2016).

Teachers of Color in White STEM Spaces

In light of research correlating the presence of teachers of color with the academic success of underperforming students of color, recruiting and retaining teachers of color has become a growing concern for teacher-education programs, districts, and schools (Sleeter, 2001; Sleeter & Kushamiro, 2014). Numerous studies demonstrate that the focus and design of teacher training is for White teacher candidates, and the voices of teachers of color are either ignored or silenced within classes (Amos, 2010; Parker & Hood, 1995; Sheets & Chew, 2002). When compared to their White counterparts, practicing teachers of color are 24% more likely to leave the field per year (Ingersoll & May, 2011).

In addition to the training, the research also speaks to the professional environment teachers of color must navigate. From Americanizing schools that worked to intentionally strip indigenous youth of their cultural identity (Zitkala-Sa, 2009), and White paradigms infiltrating Black segregated school contexts (DuBois, 1935; Woodson, 1933), to Eurocentric curricula in the textbooks today (Loewen, 2008), schooling in the United States has worked to diminish the self-worth of students of color. It is because of these Eurocentric frameworks that teachers of color are often not able to engage holistically, or to grow in ways that accomplish their goals or advocate for their communities (Kohli & Pizarro, 2016).

While about 88% of teachers are White, more than one-third of the students in the United States are ethnically and culturally diverse (Ladson-Billings, 2005). In states like California and Texas and in most of the largest school districts across the country, "minority" students are now over 50% of the student population. Often, students whose ethnic or cultural background differs from those of their teachers are put in situations where the teacher assumes deficits in the students, rather than locating and teaching to their strengths, such as resilience, eagerness, energy, and creativity (Flores, 2007). Teachers' beliefs about student capabilities and home environments can lead to a sense of helplessness on the part of the teacher. This helplessness can result in lower expectations, ineffective teaching, and reinforced stereotypes (Irvine & York, 1993). Low expectations lead to fewer opportunities for students to learn more challenging and advanced mathematics (Flores, 2007).

There are many studies that speak to the importance of having high-quality teachers of color who utilize innovative teaching techniques to help increase URM persistence in STEM (Moller et al., 2014; Sanchez, 2014). As Strayhorn (2012) summarized in his review of the research, a sense of belonging is associated with academic achievement, retention, and persistence in college, and these impacts are frequently more pronounced for URM students. More specifically, the nature of the interaction between faculty and student, and the degree to which a student can feel that they are part of a shared positive experience, might be the single greatest intervention available for identity contingencies (Cohen & Garcia, 2008). Belonging in the classroom is predicated on the notion that student success in the course is a shared responsibility between all students and the instructor (McMillan & Chavis, 1986). This sense of

belonging or mattering is reinforced by Bettina Love. According to Love (2019), mattering is a quest for humanity. Mattering is the internal desire all people have for freedom, joy, restorative justice (restoring humanity—not rules), to matter to ourselves, our community, our families, and our country with the profound understanding that we must "demand the impossible" by refusing injustice and the disposability of dark children.

In Rainey et al.'s (2018) study on race and gender differences in how sense of belonging influences decisions to major in STEM, they found that as a student's demographic group becomes less represented, they are less likely to report a sense of belonging. Rainey et al.'s results also concur with the studies of Good et al. (2012), Johnson (2012), and Smith et al. (2013), which stated that within STEM, both women and students of color have consistently reported less sense of belonging than men and White students.

Impact of College Counseling

Starting in adolescence, URM students in the STEM fields face a lack of support and encouragement and, oftentimes, direct discouragement from educators regarding enrollment in rigorous STEM coursework (Grossman & Porche, 2014). A key factor that is often not discussed but is consistently leveraged in privileged high-school environments is the availability and effectiveness of school counselors. Counselors serve an important role in working with math and science teachers to develop curricula that are unbiased and culturally sensitive to the needs of female and minority students (J.Mau et al., 2016). Under their role as defined by the American School Counselor Association National Model (2012), professional school counselors play an integral part in utilizing career counseling to support and encourage students to pursue STEM education and careers (Schmidt et al., 2012). Although they might work with students individually to deliberately integrate STEM knowledge into student goal setting, they also play multiple roles within the system of the school (Schmidt et al., 2012).

Similar to teachers, the ethos of these professionals can have a profound effect on students pursuing STEM majors in college. Cabell et. al. (2021) found that for URM students in STEM, high-school counselors can make a difference by exposing them to possibilities and opportunities in STEM. In order to provide equitable and anti-racist school counseling services, professional school counselors must be knowledgeable and aware of the factors perpetuating the opportunity gaps in STEM for girls and URM students (Cabell et al., 2021).

However, there are barriers surrounding these efforts, including inadequacy of education around STEM for school counselors; challenges with supporting parents, especially parents from marginalized racial identities; and having insufficient resources to benefit students (Shillingford et al., 2017). Additionally, for Black and Latinx students, the availability of counselors is a challenge. Corwin et al. (2004) suggested that counselors in schools serving more Black students have higher student–counselor ratios, receive fewer resources toward college planning and preparation, and operate under a limited schoolwide emphasis on college access.

These studies show that while school counselors can target STEM self-efficacy and have an important role in promoting STEM career aspirations with racially URM students, these students are less likely to expect their school counselors to share postsecondary information with them, and school counselors often miss opportunities to improve URM students' STEM outcomes (Dockery & McKelvey, 2013; Shillingford et al., 2017). The mental models of educators, whether they are in the K–12 setting or in the university classroom, have a real impact on students navigating and persisting in STEM. URM students who enter STEM majors at selective college environments where they are expected to fail in the major will fulfill this

prophecy in droves (Bonous-Hammarth, 2000). Whether it is educators or even the neighborhood a student encounters, the educational context a student navigates can be a determinant of their final academic destination, even more so than their actual academic ability.

This point is made salient in the findings of Hoxby and Avery's 2012 study, which sought to understand the factors that contribute to undermatching. Hoxby and Avery (2012) examined the differing applicant behavior of high-achieving, low-income students versus their high-achieving, well-resourced peers. Their findings showed that when students are low-income, they tend to make college decisions that are typical of those of their income level and not of their achievement level. These decisions are informed by the educational context students navigate. All of these environmental factors have a significant impact on a student's applicant behavior, regardless of their achievement.

Taking a systems approach makes it possible to acknowledge the role of educators and the educational context they provide students in their schools rather than the characteristics of the students themselves. The propensity for Black and Latinx students to engage in STEM experiences is largely dictated by curriculum availability and participation, and the beliefs of teachers, counselors, and other educators.

Summary

The application of two of the tenets of critical race theory in education (Ledesma & Calderón, 2015), in this research, allowed the interrogation of how majoritarian structures have shaped and framed educational access and demonstrated how postsecondary institutions perpetuate a privileged normative concept of who students are and what a successful student looks like despite the inequitable access to qualifying experiences. Additionally, the anti-deficit framework required me to excavate efforts that seek to rebalance the causes behind the misrepresentation in STEM.

Upon reviewing the literature to understand the environments that positively contribute to students' participation in STEM, the impact of the lack of access to those environments for URM students, and the role of educators in generating engagement in those environments, it should be concluded that the lack of Black and Latinx students pursuing STEM is the result of educational structures that create racial disproportionality. Failure to acknowledge the racial impact is an injustice to critical race scholarship (Harper, 2010). While there are solid bodies of literature that examine the factors that contribute to this underrepresentation as well as research on URM student experiences in STEM majors on college campuses, there is a lack of research on the role university admission leaders play in supporting or disrupting the underrepresentation in STEM majors.

Chapter 4: Methodology

This chapter presents the research framework and design for the purpose of understanding how CAOs characterize the URM pipeline into STEM majors and what they are doing about it. This chapter first reiterates the research questions and describes the qualitative research design. Then, I describe research sites and context before describing the qualitative data collection process, which includes participant selection criteria, sampling methods, data collection procedures, and instrument construction. Lastly, I explain the data analysis phases and discuss the research design's ethical considerations, assumptions, limitations, and delimitations. To protect the identity of the research participants, pseudonyms are used for the individuals and institutions they represent.

Research Questions

A critical perspective missing from the research on the STEM pipeline is that of the CAOs. Understanding the perspective of the leaders who sit at the nexus of college access illuminates the challenges of and strategies for addressing the pipeline. This research study seeks to examine two questions:

- How do chief admission officers in R1 public flagship universities characterize and analyze the challenges and inequities that URM STEM applicants face in the admission process?
- Are there ways that chief admission officers of R1 public flagship universities create opportunity and access to STEM majors for URM students?

Research Design

I used qualitative research for this study, as this method is useful in identifying problems by observation, conversation, and document analysis while focusing on understanding participant experiences and meaning-making (Creswell & Creswell, 2017; Merriam & Tisdell, 2016). Locke et al. (2010) stated that qualitative research offers the researcher greater flexibility in allowing for an adaptive structure as the study unfolds. Qualitative research allows for an inductive approach, providing the researcher with the ability to gather data and build concepts to generate theories based on research (Creswell & Creswell, 2017; Merriam & Tisdell, 2016).

Throughout this research, I used a social constructivist framework. Social constructivism, as defined by Creswell & Poth (2018), is a paradigm in which individuals seek an understanding of the world in which they live and work. I engaged admission leaders at public universities about the impact they have on the environments in which they work. As I seek to understand a phenomenon and its interaction with practitioners, this framework of social constructivism resonates with my research design for this inquiry.

As I am exploring a real-life issue, I used case studies as my methodology. Using a multiple case study approach (Yin, 2018), this inquiry centers on the misalignment between STEM college admission requirements and the accessibility of these prerequisites for Black, Latinx, and low-SES students. The primary focus is to examine how admission leaders understand and address this misalignment across various institutions. Creswell (2013) stated that the intent of the case study is to provide in-depth understanding through data analysis of multiple sources of information, describing all details of the case where themes or issues are identified by the researcher. With a goal to recognize behavior patterns and understand complex social

phenomena, the collection of observations will begin to illuminate a pattern of understanding and practice of college admission leaders in regard to college admission to STEM for URM students.

Research Sites and Context

The sites for this research will be public flagship universities that have an R1 designation located throughout the United States. Supported primarily by state government funds, flagship public universities have unique characteristics: access to a wide range of citizens from different economic, social, and geographic backgrounds; engagement with economic development and public service by offering academic programs that range from the liberal arts to engineering to help fuel economic development and social mobility; and leadership by setting standards and developing other sectors of a state's evolving education system—from elementary and secondary schools to other public tertiary institutions (Douglass, 2014). According to the Carnegie Classifications of Institutions of Higher Education, R1 institutions (also known as doctoral universities with very high research activity) offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, give high priority to research, conferred at least 20 research/scholarship doctorates in the 2019–2020 school year, and reported at least $5 million in total research expenditures in FY20 (American Council on Education, n.d.). Given the access-oriented mission of flagships and the exclusive values of STEM and research, the intersection of public flagship and R1 institutions provides a unique landscape to navigate for undergraduate admission leaders and lead the charge of who belongs and how we define merit. All of these institutions enroll thousands of undergraduates, and despite having varying acceptance rates, all describe the selectivity of their STEM programs as being much higher than the general admission requirements. Additionally, all of these institutions have historically been categorized as predominantly White institutions. This means that these institutions have historically had an enrollment of 50% or more White students. Although the demographics have shifted at these institutions, they are now considered to be historically white institutions. More information on these important institutions and the CAOs who run their admission processes will be provided in Chapter 5.

Qualitative Data Collection Procedures

Upon approval from the University of California, Berkeley Committee for Protection of Human Subjects, I began the participant recruitment and data collection procedures. Table 3 shows the timeline for the entire data collection process.

Table 3

Timeline	Research Progress
Nov 2022	Pilot study
May 2023	Successfully defended the dissertation proposal
Jul–Aug 2023	Acquired IRB approval for this study
Aug–Oct 2023	Recruited 6 participants; collected informed consent forms; collected admission criteria from institutional websites; distributed and collected pre-interview questionnaire; revised interview protocol; conducted six interviews
Nov–Jan 2023	Completed three phases of data analysis

Data Collection and Analysis Timeline

The qualitative data collection procedures for this study included four sections: 1) participation selection criteria, 2) sampling method, 3) data collection procedures, and 4) instrumentation.

Participant Selection Criteria

The participants in this study were admission leaders at the time of this study. Participant recruitment was based on the following selection criteria. The six individuals and institutions that met the inclusion criteria:

1. Hold the role of CAO
2. Their current institution must be R1 designated
3. Their current institution must be a historically predominantly White institution
4. Their current institution must be public flagship university
5. Must be able to complete the University Admission Leadership Questionnaire
6. Must be able to participate in a 90-minute interview

Table 4 provides a brief summary of the research participants; additional details are offered in Chapter 5.

Table 4
Research Participants & Sites

CAO	Gender	Race	University	Undergraduate Size	Admit Rate
Mr. St. Patrick	M	B	Redwood Central University	18,000	56%
Mr. Miles	M	B	Harmony University	18,800	72%
Dr. Taylor	M	W	Central Highlands University	24,800	95%
Mr. Montgomery	M	W	Horizon Hills University	21,100	86%
Mr. Gavin	M	W	Riverdale State University	17,000	21%
Ms. Green	F	API	Willowdale University	13,800	70%

Sampling Method

I utilized a purposive sampling method to identify leaders who would bring a perspective to the literature that is currently missing: the voices of admission leaders who currently serve historically predominantly White institutions. Purposive sampling is widely used in qualitative research for the identification and selection of information-rich cases related to the phenomenon of interest (Cresewell, 2018). Purposive sampling is the chosen strategy when researchers are soliciting participants to ensure that the sites and participants are appropriate to answer the study research questions (Davies & Dodd, 2002; Braun & Clarke, 2006). For a multiple-case study in pursuit of analytic generalizations from the examined cases, selecting the appropriate cases addressing research questions is a fundamental task to complete (Yin, 2018). The sampling method is purposive because only CAOs situated at these institutions can meet the selection criteria and be invited to participate in the study. The commitment to broad access and high-quality scholarship highlights the terrain these CAOs must navigate while addressing the public expectation of belonging at their state institution. It is through this narrowly defined lens that my research aims to understand how these leaders address the STEM inequities in their admission processes.

Instrumentation

One of the most important features of a case study is the use of various applicable data from multiple sources, which enables an in-depth and contextual analysis of a phenomenon (Yin, 2018). Researchers using case studies, therefore, are expected to gather extensive information through various data collection techniques (Creswell & Creswell, 2017). I developed two instruments to collect information from the participants and their research sites: a leadership questionnaire (see Appendix A) and an interview protocol (see Appendix B), as well as a collection of publicly available admission and STEM admission criteria at each institution for triangulation.

University Admission Leadership Questionnaire

Prior to the interview, participants completed the university admission leadership questionnaire. Eugene Bardach (2009) stated, "In policy research, almost all likely sources of information, data, and ideas fall into two general types: documents and people" (p. 69). The questions were designed with reference to the American Council on Education's presidential profile questionnaire. This questionnaire provided demographic and career information of the participants. The questionnaire also provided institutional context for the role of CAO, where it is situated within an institution, and possible large institutional systems.

Semi-Structured Interviews

I conducted one-on-one, semi-structured interviews of CAOs to determine how they understand the challenges and create opportunities for URM applicants to STEM. Semi-structured interviews incorporate both open-ended and more theoretically driven questions, eliciting data grounded in the experience of the participant as well as data guided by existing constructs in the particular discipline within which one is conducting research (Galletta, 2013). Prior to the interviews, I revised the interview questions to ensure they were developed based on the research questions, topics, and themes from the literature. Appendix C shows how the interview questions align with the research questions in order to discuss the findings in later sections. I utilized Zoom video technology and stored the recorded interviews on an encrypted folder approved through the IRB process. Participants were asked to set aside 90 minutes for the interviews. These interviews provided valuable insights into how the participants characterize and engage with the factors that URM applicants navigate and if they are able to provide access to STEM majors.

Positionality: College Access Through the Lens of a Practitioner

In this research, I strive to bring an understanding of college access through the lens of a practitioner, specifically a practitioner of color, with a career grounded in diversity recruitment concepts of equity, access, and inclusion. In this section, I will explain how my career as a college admissions professional is informing my approach to research and literature.

As a second-generation Nigerian American from a small, predominantly white town, I always had access to adequate schooling and schooling resources. As the son of Nigerian parents who immigrated to the United States through student visas, my family has heralded education as the greatest engine for economic and social mobility. I attended predominantly white primary and secondary schooling.

As an admission officer, I traveled to hundreds of high schools across the Mid-Atlantic region and began to observe the disparities in educational environments that young people navigate. Weaving in and out of public and private schools throughout Philadelphia, Camden, Baltimore, and Washington, DC, I observed schools with manicured lawns and golf courses just blocks from schools with bars on the windows and metal detectors. While I could identify with the few Black students in the well-resourced schools, it was not lost on me that most of the students in the less desirable schools were students of color. As my job required me to communicate the advantages of attending my institution, I realized that the message and pitch that I was trained to give was crafted to entice students who had particular high-school educational experiences, and was not for everyone.

Like many others in the college admission profession, I was committed to finding those students who, despite having disparate experiences, were able to be competitive in my applicant

pools—students who were going above and beyond what their educational environments provided, with big dreams to reach a world that many in their neighborhood would not.

As I continued in the profession, I found myself steeped in the factors and theories that move the undergraduate admission industry forward. After working at different types of postsecondary institutions (small private, public land-grant, and Ivy League), I began to understand trends in how the work was discussed with the public and amongst practitioners. Most importantly, I learned the impact entities outside of an actual institution can have on how schools evaluate their applicants. From test agencies to communities of practice, these additional entities help set industry standards and best practices around admission and frame the college access conversation.

Also informative to my praxis and connection to the topic of Black and Brown scholars is the acknowledgment of my existence as a Black educational leader as a threat to white supremacy. Throughout my time as a practitioner, the deaths of Trayvon Martin, Mike Brown, Freddie Gray, and the state-sanctioned murders of Sandra Bland, Philando Castile, and George Floyd have forced me to critique societal systems of oppression (policing) while also questioning my role in upholding another (education). This dissonance with my identity as a leader of influence within an oppressive system lays a path of resistance that calls for urgent liberation from the inside out.

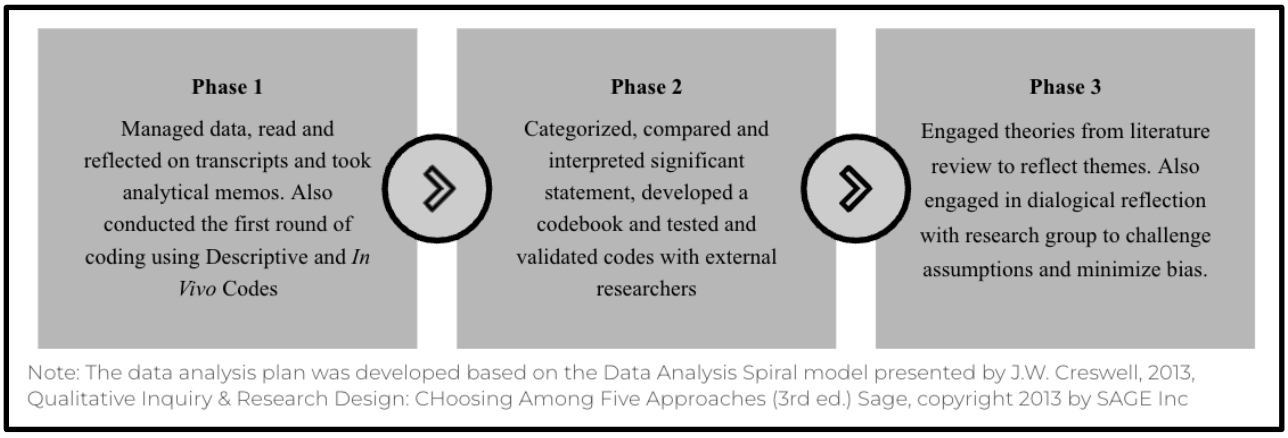
When I began my career with the University of California, it was the first time I had taken on the role of CAO. Additionally, I now had to navigate legislation that completely changed how achieving diversity in admission could be achieved. With a statewide affirmative action ban that dated back to 1996, I had to pivot to race-neutral strategies. My approach to this dissertation and interest in the larger topic of equity in college admission came into great focus on June 29, 2023, when the United States Supreme Court ruled in favor of Students for Fair Admissions and barred the use of race in college admission nationally. Without the consideration of race, the hardest part of the academy to diversify has been STEM, given the consistent additional criteria that are often required. When reflecting on the varied schooling environments I visited, I know that many Black students are damned from the start because of their academic opportunities.

In response to this, I combined the tenets of CRT in education to critique the college admission profession while also utilizing anti-deficit theory and affirmative meritocracy to offer strategies for CAOs to employ to achieve more equity in STEM. I used these frameworks to contextualize the factors that impact college admissions and highlight how some leaders are showing their commitment to equity in competitive environments. I selected this topic and arena because in order to create true equity in college admission, the concepts of merit and equity need to be addressed.

Data Analysis Procedures

As can be seen in Figure 2, data analysis consisted of three phases. I began the first data analysis with secure data storage. I read through the interview transcripts, familiarized myself with all the data, and took notes using fundamental concepts and short phrases to describe the participant's personal experiences and observations. Then I conducted my first coding cycle, combining two methods: descriptive and in vivo coding.

Figure 2
Three Phases of Data Analysis



Note: The data analysis plan was developed based on the Data Analysis Spiral model presented by J.W. Creswell, 2013, Qualitative Inquiry & Research Design: CHoosing Among Five Approaches (3rd ed.) Sage, copyright 2013 by SAGE Inc

In Phase 1 of the analysis, I conducted the interviews virtually and recorded them in order to capture the contextual and nuanced answers provided by the interviewees. After transcribing the interview with Rev.com, I reviewed the transcript and went through the process of identifying patterns in the responses and manually developing codes. Coding is the process of organizing data by bracketing chunks (or text or image segments) and writing a word representing a category in the margins (Rossman & Rallis, 2012). More specifically, I utilized *in vivo* coding. *In vivo* coding is a form of qualitative data analysis that places emphasis on the actual spoken words of the participants. This form of coding can be especially helpful when researchers interact with participants from a particular culture or microculture to help highlight how those participants use specific words or phrases in their interactions that might not otherwise be understood when using other forms of coding (Saldaña, 2016). In vivo coding helped excavate the language used in the culture of college admission and provide meaning for analysis.

In the second cycle of coding, I interpreted the significant statements, reflected and compared different codes, and established themes. Through this round, I was able to develop a codebook and tested the codes with external researchers to ensure the consistency of their application and intercoder agreement.

For the third phase, I engaged theories from the literature review to reflect and reorganize the codes into themes. In the second and third cycles, I applied simultaneous coding when I recognized the interconnectedness among the codes and layers, and the nuances contained in of a passage of data (Saldaña, 2021). I also engaged in dialogical reflexivity with my research group to ensure the proper application of the codes to the theories from the literature review.

Validity and Trustworthiness

To enhance the study's credibility, I also gathered institutional data from all of the publicly available admission websites. I gathered information from admission websites and publications to understand the espoused values of each institution as well as to uncover the stated admission criteria for new students. Additional data was collected specifically in regard to any additional criteria for students applying specifically to STEM disciplines. Triangulating different data sources allows the researcher to ensure internal validity in order to build a coherent justification for themes (Creswell, 2018). The stated admission criteria showcase the admission

process from the perspective of the applicant while also providing an understanding of what the institution deems necessary for admission.

The instrumentation construction was also considered validation. I refined interview protocols in order to ensure that collection questions would answer the research inquiry. Chapter 5 provides detailed descriptions of the data analysis for readers to determine the transferability and generalizability of the study.

Additionally, to avoid research bias, I practiced reflexivity to "intentionally reveal underlying assumptions or biases that cause the researcher to formulate a set of questions in a particular way and to present findings in a particular way" (Mills & Gay, 2019, p. 561). For this reason, I kept a journal with memos, checked codes for validity and application, and discussed emergent themes with my research group.

Limitations and Delimitations

There are several limitations to this study. Given the time constraints of this study, which took about seven months for participant recruitment, data collection, data analysis, and writing, I used a purposeful sampling method. Another limitation is the lack of public access to admit rates to STEM disciplines. Without the admit rates for those majors, my ability to triangulate the perspectives given by the CAOs was limited. The participants are bound by the type of institution being studied. Additionally, the participants were asked about admission practices that took place prior to the July 2023 Supreme Court decision to ban the consideration of race in college admission. Another limitation could be found in the scale of this study, which explored only institutions that have the R1 and public flagship designation. The perspective of these institutions does not represent that of other public universities or private colleges that have different service missions and different institutional pressures.

I made intentional choices about the scope and approach of this research. The first delimitation was to employ the anti-deficit framework (Harper, 2010). A framework used specifically to study the achievement of minority populations in STEM, Harper (2010) explained that researchers using this framework should deliberately attempt to discover how some students of color have managed to succeed in STEM. This informed my research inquiry and interview protocols to understand how CAOs are providing access despite the many challenges in the pipeline. Focusing on STEM admission was another delimitation. STEM majors are some of the most popular majors on college campuses and oftentimes have much more selective admission processes. As a collective case study, it was essential to understand precisely how CAOs are providing access to these highly sought-after majors. Finally, I chose to bind the research sites with the combination of R1 and public flagship institutions because these CAOs have academic and public pressures around college access that are unique in the profession. There is tension between the commitment to high-quality research that is required of the R1 designation and the access orientation of the institutional mission. These 66 institutions are some of the largest in the country. Understanding how CAOs are navigating this tension will be necessary for the entire field of college admission to learn the strategies employed by these leaders.

Chapter 5: Profile of the Leaders and Their Campuses

The purpose of this chapter is to describe further the research participants and the institutions in which they currently serve. This research was structured as a multiple-case study incorporating six cases. Having more than one case allowed me to observe and compare different types of leader experiences and leader–context interactions. Limiting the study to six cases provides a manageable scope for exploring the participants' practices in significant depth with attention to dynamic and nuanced aspects of their thinking and acting within the context of their work environment. Qualitative research should produce thick, rich, and detailed data (Ravitch & Carl, 2016; Maxwell, 2013) that "allows the reader to experience vicariously the essential features of the experiences that are described and does not gloss what is being described" (Ravitch & Carl, 2016, p. 201). Participants' thoughts and feelings are conveyed through rich data, including verbatim transcripts of the interviews, and by using thick descriptions (Ravitch & Carl, 2016) to present themes using participant quotes to conceptualize the data for readers. Maxwell (2013) asserted that rich data is collected through intensive interviews that provide "a full and revealing picture of what is going on" (p. 126).

This chapter provides a description of each participant and their leadership experiences as they relate to their role as CAO. Additionally, each case provides a description of the institution in which they currently serve and the nuanced attributes of their respective admission criteria to STEM majors.

Case One: Mr. St. Patrick, Redwood Central University

Mr. St. Patrick is a Black man who has been in the college admission profession for more than 25 years. He received his master's degree in 2004 from a large public university. He is currently in his second stint as a CAO after working at 3–5 universities prior to his current appointment. Throughout his career, he has been employed only by public universities and held a CAO title for over a decade. For the past five years, he has led Redwood Central University as the Director of Undergraduate Admission. Mr. St. Patrick oversees the main campus and Redwood Central's additional satellite campuses in this role and reports to the Vice President of Enrollment Management.

Redwood Central University's main campus enrolls more than 18,000 undergraduate students and has an admit rate of 56%. With over 115 majors spread across eight colleges, Redwood Central University's website describes additional admission requirements for applicants interested in STEM majors. These requirements include demonstrated participation in additional and higher-level high-school courses in the sciences, with a focus on physics.

Case Two: Mr. Miles, Harmony University

Mr. Miles is a Black man who has a career in college admission that began more than 25 years ago. He earned his master's degree in 2000 from a small private university. Mr. Miles is currently in his fourth stint as a CAO after working at 6–9 different institutions prior to his current appointment. In total, Mr. Miles has been a CAO for nearly 15 years. Additionally, Mr. Miles spent time as a corporate recruiter prior to taking on his first CAO role. Mr. Miles is in his fourth year as the Vice President of Enrollment at Harmony University, where he reports to the President and the Provost. He oversees Harmony University's main campus and three satellite campuses in this role.

Harmony University's main campus enrolls nearly 19,000 undergraduate students and has an admit rate of just over 70%. With over 140 majors spread across eight colleges, Harmony University requires four years of mathematics with at least precalculus to be considered for STEM majors. More specifically, Harmony University's website states that students who attend high schools that do not offer entry-level math requirements must transfer into STEM majors after they have completed all necessary prerequisites.

Case Three: Ms. Green, Willowdale University

Ms. Green is an Asian woman with 20 years of professional experience in the admission profession. She received her master's degree from a well-known private university prior to beginning her career in 2003. This is Ms. Green's second stint as a CAO but her first time at a public flagship institution. She has worked at 3–6 institutions prior to her current role and has been the CAO at Willowdale University for the past three years. In her role as CAO, Ms. Green oversees Willowdale's single campus and reports directly to the Provost.

Willowdale University enrolls just under 14,000 undergraduate students and has an admit rate of 70%. Willowdale offers 200 degree programs spread across 18 colleges and schools. For the College of Nursing, Willowdale has a separate application and an additional application fee. For the College of Engineering, Willowdale lists stated preferences for higher levels of math rigor, such as calculus, physics, and chemistry.

Case Four: Mr. Montgomery, Horizon Hills University

Mr. Montgomery is a White man who has been a college admission professional for more than 20 years and earned his master's degree from a large public university. Mr Montogomery is currently in his second stint as CAO and has been in the role for nearly a decade. Mr. Montgomery has worked at 3–6 public universities of various sizes throughout his career but has been at large flagships for the last 15 years. Mr. Montgomery also has experience in graduate admission. For the past ten years, he has been the Assistant Provost and Director of Admission at Horizon Hills University, where he oversees a single campus. In this role, he reports to the Vice President of Enrollment.

Horizon Hills University is a large university that enrolls just over 21,000 undergraduate students and has an admit rate of over 85%. Horizon Hills offers more than 200 undergraduate programs spread across eight different colleges and schools. For students interested in majoring in engineering, Horizon Hills requires students to complete additional and higher levels of math and science, including a minimum of precalculus and a highly recommended physics course.

Case Five: Mr. Gavin, Riverdale State University

Mr. Gavin is a White man and is the most seasoned admission professional in this study, with more than 30 years of experience. He received his master's degree from a small, well-known private school. Although Mr. Gavin's career dates back to 1994, this is his first time appointed to the CAO role. Prior to joining Riverdale State University, Mr. Gavin worked at two other institutions, both private universities. After a few promotions, he began serving as the Associate Vice Provost for Enrollment and Undergraduate Admission at Riverdale State University and has continued to do so for the past 15 years. In his role, he oversees a single campus, and he reports to the Vice Provost of Enrollment.

Riverdale State University enrolls just over 17,000 undergraduate students and is the most selective institution in the study, with an admit rate of 21%. Riverdale State offers more

than 70 undergraduate majors spread across five different colleges. While the additional rigor is not prescriptive for students interested in engineering, admitted students are typically in the top 10% of their high school class and have exceptional standardized test scores.

Case Six: Dr. Taylor, Central Highlands University

Dr. Taylor is a White man who has been a college admission professional for 16 years. He earned his Ph.D. in education in 2012 from a large public university. Dr. Taylor is currently in his first CAO role. His career spans the United States, with experience at 3–6 institutions whose locations span from California to New York. Additionally, Dr. Taylor has held admission and teaching roles at the undergraduate and graduate levels. Dr. Taylor has also worked at private and public institutions throughout his career before landing at this public flagship university. Dr. Taylor is currently the Executive Director of Admission at Central Highlands University, where he has been for nearly four years. As the Executive Director of Admissions, he reports to the Vice President of Enrollment and oversees the admission process of Central Highlands University's single campus.

Central Highlands University is the largest university in the case study, enrolling just under 25,000 undergraduate students. Central Highland University admits 95% of its applicants. With 100 undergraduate programs spread across 18 colleges and schools, Central Highlands University has additional admission criteria for applicants interested in STEM. Even with a 95% admit rate, students interested in being directly admitted to engineering majors must demonstrate a high-school GPA of 3.6 or higher and a strong score on the math section of a standardized test (ACT or SAT) or a GPA of 3.8 or better, and an advanced score on the AP Calculus exam.

Summary

The single-case profiles of the research participants allow for a better understanding of the CAOs, the universities in which they work, and the institutional nuances around STEM admission. By taking a closer look at these leaders and their institutions, it can be seen that although the participant criteria bound each site, there is variance among the cases that may impact the way CAOs characterize the challenges in the STEM pipeline and the approaches they employ to provide access for URM students. In order to contextualize the findings, the following chapters provide a clearer picture that is helpful in understanding the perspective of these CAOs.

Chapter 6: Damned From the Start: Acknowledging the Misalignment of STEM Admission

This is the first of three chapters that aim to illustrate the significant findings of the selected institutions following the research procedures explained in the previous sections. I completed individual case studies on the six select case institutions, focusing on how CAOs characterize and navigate the challenges of diversifying the STEM majors at their respective universities. The finding presented in this chapter is directly in response to the first research question, which asks CAOs how they characterize the challenges URM STEM applicants to RI public flagship universities face in the admission process.

Overview of Finding One

In order to address this first research question, it was necessary to understand the dynamics that CAOs must navigate, particularly regarding their perspective on the URM pipeline to STEM majors at their respective institutions. Through this inquiry, participants described policies, practices, and beliefs contributing to the challenges of admitting URM students to STEM majors. The CAOs characterized several challenges URM students face in the application process and provided insights into the dynamics contributing to the challenge.

This analysis highlights two significant themes that emerged from their responses. CAOs characterized the challenges and inequities as shaped by both internal institutional factors (like public mission fulfillment, current enrollment goals, and additional STEM admission criteria) and external environmental factors (such as state-specific K–12 contexts and initiatives, academic opportunity gaps, and relationships with neighboring universities). The convergence of these factors describes a daunting path that keeps URM students underrepresented in STEM majors.

All participating CAOs identified institutional and external challenges that create a complex environment for URM applicants to STEM. When discussing internal factors, CAOs described the tension of navigating the access orientation of the public flagship mission, current enrollment goals, and the additional admission requirements for STEM majors. For external challenges, the CAOs described statewide context and initiatives, the impact of varied academic opportunity gaps of applicants in their pools, and their relationship to other universities in or around their home state as impactful factors to admission. Together, these factors speak to the layered challenges CAOs face when seeking to admit URM students to their institution's STEM majors.

Table 5 provides a snapshot of the key themes and sub-themes that will be discussed and evidenced in this chapter.

Table 5
CAOs' Characterization of Challenges to Admit URM Students to STEM Majors

Theme & Sub Themes	Description	Participant Example
Institutional Factors that Impact College Admission Decisions ○ Public Flagship Mission ○ Enrollment Goals ○ Additional Admission Criteria for STEM Applicants	Participants describe nuances specific and internal to their institution that impact admission practices and outcomes.	"If you did not have a certain calculus course, if you didn't have certain science courses, we could not even consider your application for both computer science and nursing." —Mr. St. Patrick, Redwood Central University
Environmental Factors that Impact College Admission Decisions ○ State Context & Initiatives ○ Academic Opportunity Gaps ○ Relation to other schools	Participants speak to the factors external to the admission office and university that impact admission practices and outcomes.	"I think the first thing is really understanding what is happening on a K through 12 and higher ed. What's the landscape like for all students." Mr. Miles, Harmony University

Institutional Factors that Impact College Admission Decisions

In their responses, institutional factors that impact admission decisions were significant in the CAOs' understanding of the challenges for URM students applying to STEM. When asked about those institutional factors, three themes emerged as salient institutional factors: delivering the public flagship mission, current enrollment goals, and the additional admission requirements for STEM. These internal factors were thematic and highlighted the tensions and barriers that emerge in providing access to STEM majors.

Public Flagship Mission

Public flagship institutions, being land-grant universities, share a common mission of educating as many state residents as possible. It is crucial to understand that this objective is a key part of the founding principles and the primary purpose of these institutions' existence today, as described in Chapter 2. This point is made salient by the responses of the participants. In the interviews, CAOs spoke about their respective public flagship missions and the importance of aligning their undergraduate admission goals with those of the broader institution. When describing the admission priorities informed by the public flagship mission, Mr. Montgomery said, "I think in our state, it's access. It is outreach and service. It is being present in all the communities around our state." This commitment to educate the entire state was supported and built upon by Mr. Miles, who discussed the historic public flagship mission, the university strategic plan, and its impact on admission's mission.

> And so I think that is part of our mission, access and opportunity, and that's part of the university strategic plan as well. So I think aligning with understanding the school strategic plan and mission, aligning the programs that we have that speak to that, and affordability as well. And I think as the chief enrollment officer that's part of the

> responsibility, to say, "What are those gaps and what do we need to do to continue to address those gaps?"

This alignment is not just in theory. Mr. Montgomery went on to describe the access-oriented institutional mission impact on admission: "There's a real rallying cry here, not only with our admission staff, but I'd say our campus community as well." This commitment again emerged as Mr. Gavin explained how he is "anchoring funds and some values tied to the president's strategic plan." The interpretations of the public flagship mission can often be held as justification to diversify or to focus on other components of the applicant pool. When the latter ensues, the public flagship mission can be a unique barrier to URM students, especially at institutions that seek to educate the "best and brightest." The evolution of understanding to action resulted in CAOs describing their charge to serve the institution's public flagship mission as impactful to how they construct their admission operations.

Enrollment Goals

In addition to the historic nature of the institutional mission, delivering on current enrollment goals was also characterized as an institutional challenge to diversifying STEM. As a function of their role, CAOs have a recurring conversation with university leadership about enrollment goals. These goals determine how success is determined when bringing in a new class of students at varying institutions. Across the respondents, the most consistent enrollment goals were overall enrollment growth, increasing nonresident enrollment, and increasing diversity.

These enrollment goals were concrete in the minds of respondents and often communicated to them upon arrival at the institution. When asked about enrollment goals she was confronted with, Ms. Green explained, "It's growth, but I've only heard it from the president and somewhat from the provost. And I heard it in my search, so I knew that was the task in front of me." Other CAOs echoed this enrollment-growth goal as a goal from campus leadership. In delivering on this goal to grow, CAOs spoke to the importance of educating university leaders on the impact of enrollment growth on the rest of campus. Dr. Taylor remarked, "I've been told we want more freshmen. And I oversee undergrad and graduate [admission]. And so it is a balance of having conversations with the president's office about, 'This is what makes sense for a growth goal for undergrad.'" The progress of an enrollment-growth goal is measured by the size of the class rather than its composition, and this leaves CAOs to focus on the most attentive populations in their applicant pool rather than on those who are underrepresented. With efforts squarely on growth, considerations of diversity can oftentimes be compromised due to other barriers that would limit URM students' potential to enroll, like cost of attendance and location.

As employees of land-grant institutions, CAOs all mentioned the need to negotiate the composition of residents in each entering class. Increasing the number and percentage of nonresident students was a consistent enrollment goal the participants described as something to navigate. Mr. Montgomery explained:

> Our five-year strategic enrollment management plan is one that's pretty consistent in terms of overall enrollment, with an acknowledgment that we're going to have to start growing more of our national markets . . . , but we've had investments in additional regional staff to help us build enrollment from other markets and become a destination university for certain programs.

Respondents consistently reported that in order to deliver on other enrollment goals, whether it be increasing diversity or increasing enrollment, they could not rely on the state population. Mr. Montgomery went on to say, "A lot of our underrepresented students are coming from out of state, and so [we need to be] building those types of networks, and working with our out-of-state markets to continue to do that."

However, diversity is not the only factor; the growth of the nonresident student population is also attached to revenue generation for the institution. Mr. St. Patrick described that his campus leadership is

> [. . .] interested in increasing the enrollment of more nonresident students. And just strictly from a revenue standpoint, it costs more for the institution to educate in-state students than does out-of-state and international students because of the financial leveraging that the state already does for in-state students.

This assertion was supported by Dr. Taylor, who responded to questions about increasing nonresident enrollment by explaining, "All of this, of course, is in an effort to increase revenue for the university." This focus on revenue generation encourages CAOs to do more outreach and engagement in well-resourced communities that are more likely to produce applicants who do not need financial assistance or have other barriers to their enrollment. The enrollment goals of growth of the nonresident student population and revenue generation can often be in tension with the goal of increasing diversity, especially when trying to increase low-income or first-generation student populations.

In addition to enrollment growth and increasing the number of nonresident students, the desire for the institution to increase its diversity was described as an enrollment goal by all the CAOs. However, this was a broad institutional goal for most institutions in the study without a specific measurement to define success. Still, Mr. Gavin spoke to STEM fields in particular by saying, "Engineering was very interested in diversifying its student body because it was more male. We're doing a reasonable job of females, but it went more Asian and White." Even though this goal defines diversity beyond just race, respondents expressed concerns about achieving racial diversity given the unknown impact of the Supreme Court decision to ban the use of race in admission considerations. When talking about enrollment growth, Mr. St. Patrick said, "[I'm concerned with] the access goals around first-generation students, around underrepresented students of color at the institution, particularly in light of the Supreme Court cases." When the institutional focus is on enrollment growth and revenue generation, CAOs must work to seek those who can make the university the most money. Given the rising cost of college, this often leaves URM and low-income students as an afterthought. Institutional enrollment goals define the success of the CAO. CAOs explained that when these goals are prioritized, there can be tension or even opposition to the goal of diversifying STEM.

Additional Admission Requirements to STEM

The additional admission criteria for STEM applicants is the most salient institutional factor that directly impacts college admission decisions. Despite the fact that most of the institutions in this study show admit rates that assume a majority of students who apply are admitted, students must meet additional criteria in order to be considered for STEM. These additional admission criteria are explicitly set by faculty for STEM applicants, and failure to meet them can often harm their chances of being admitted to the institution. All respondents

discussed additional math and science prep as core to admission considerations to STEM majors. Dr. Taylor explained, "We're not as selective, but you have to be in calculus senior year." This is despite the fact that Dr. Taylor's Central Highlands University has a 95% overall acceptance rate for its applicants. The requirement for students to have experience with calculus reemerged across all the respondents when they discussed student pathways to engineering. Mr. St. Patrick stated, "If you did not have a certain calculus course, if you didn't have certain science courses, we could not even consider your application for both computer science and nursing."

Similar to engineering, many respondents spoke about additional requirements for those interested in pursuing nursing. Mr. Montgomery mentioned, "To be even eligible to be considered for direct admission into nursing, there's additional coursework. Physics is a class that they require." All respondents spoke to these additional curricular considerations as criteria set by the faculty that inform their process, regardless if these classes are noted as requirements or "strongly recommended" to applicants.

Beyond additional curricular criteria, CAOs mentioned the use of supplemental applications for additional screening for STEM applicants. Some respondents described additional essay requirements specific to those interested in nursing and engineering. CAOs also described the challenges with these additional requirements. Mr. Gavin described the challenge of framing these questions to applicants:

> We used to have a specific question for engineering, but even that assumed that the student would have to have a level of an understanding of engineering in a way that a lot of kids might not if they thought about engineering. They're not in robotics and sorts of things at the moment.

Similar to the class requirements, respondents described these additional essays as requirements for consideration to the STEM majors. Without these requisites complete, students may not even be considered.

These institutional factors create both barriers and challenges for students in the college application process. CAOs described the tension between carrying out the public mission to serve their home state and the current enrollment goals to increase numbers of nonresidents. They also described the additional admission criteria to STEM majors as impediments to providing access. Beyond these institutional factors, they also contextualized the environmental factors that contribute to the challenges URM students must face to be competitive in these selective admission pools.

Environmental Factors That Impact College Admission Decisions

In addition to the institutional challenges, CAOs spoke to the factors external to the admission office and university that impact admission practices and outcomes. Most salient of these external factors were the state context and state-run initiatives CAOs must navigate, academic opportunity gaps that exist within their state, and their relation to other universities within their state. Together, these factors contextualize the social, political, and legal landscape that contributes to the challenging pathway for URM applicants to pursue STEM.

State Context and State Initiatives

Repeatedly, all respondents spoke about the importance of understanding the education landscape in their respective states. Understanding that landscape includes being knowledgeable

of the data surrounding the K–12 experiences for students along with state government mandates or initiatives that CAOs must respond to as representatives of public flagship institutions. In order to deliver on the public mission of educating a diverse applicant pool, Mr. Miles mentioned, "I think the first thing is really understanding what is happening on a K through 12 and higher ed. What's the landscape like for all students." Respondents spoke about the impact of the decline in high-school students graduating from their state and feeding their applicant pools. Specific to URM students, respondents spoke to the demographics of their states and the fact that the minority populations, while growing, remain small. Mr. Montgomery explained:

> The challenge in general for a lot of our URM students is that we're a pretty White state. So a lot of our underrepresented students are coming from out of state, and so building those types of networks and working with our out-of-state markets to continue to do that is important.

When describing the challenges of working with the URM communities in the state, CAOs described the importance of those relationships. Mr. Gavin, who represents the most selective institution in the study, spoke to challenges by saying, "The relationship development was not there and, as a result, Riverdale State University was seen, and it still is to a lot of populations, as a little bit full of itself, a little bit up on a hill." Other participants discussed how these institutions were perceived as unattainable in areas of the state that had a significant population of low-income and URM students.

A notable factor that contributed to the state context was the impact of the COVID-19 pandemic. Mr. Miles explained the challenge of math prep and the pandemic's contribution to exacerbating the challenge, saying, "We've noticed that even before the pandemic, math prep was challenging. And it's even more so. Sixty percent of our incoming freshmen this year didn't place out of a non-credit course, and that was primarily in-state students." Mr. Gavin supported this point and provided some poignant context when describing who has the toughest pathway to STEM majors and why. He remarked,

> I would think it's the populations that we have the hardest time enrolling, which are often first-generation, low-income, Black, and Hispanic. And because, obviously for lots of reasons, they get a later start, that counseling caseloads are high for the counselor. They don't know how to take these courses.

In addition to the demographics of the state, CAOs remarked that state-sponsored education initiatives or requirements also have a significant impact on their admission priorities and outcomes. These initiatives are set in place by elected officials and the State Department of Education. As public entities, these initiatives are essentially mandates by the state, with which the institutions must comply. Mr. Montgomery spoke of an admission formula index that was developed by elected officials to dictate the admission standards for his institution and the other public universities in his state: "Embedded in our administrative code is a region admission index formula that says if you have the right index score, you have a path." He went on to say, "Residents that meet these standards and have this index score, they have to be admitted."

Other state initiatives try to address regional challenges of college attainment while having varying impacts on the public flagships. One CAO described a state tuition-grant program that was only for students who went to one of the private colleges in the state. "Students that go

to a public university are not eligible for any of that money," Mr. Montgomery said. Additionally, state initiatives can target areas or educational experiences in the state that they recognize as challenging for students. Mr. St. Patrick described a state partnership that incentivized admitting students from certain schools. He explained, "It's a group of schools that the state identifies as the under-resourced schools. So, we're able to consider those factors in our committee work when we're ultimately building the class that we're going to be admitting." These state contexts and initiatives make salient the second environmental factor CAOs describe as challenging: the academic opportunity gaps they observe in their states.

Academic Opportunity Gaps

With the desire to deliver on the public-access mission of educating the entire state colliding with the need to uphold additional admission requirements for STEM, CAOs discussed the challenge of the academic opportunity gaps in their applicant pool. Mr. Montgomery stated, "We know that just based on the curriculum of some of the lower-resource schools, students aren't making it to pre-calc and, in some cases, finishing up algebra." As higher-level math and science courses are requisites for entry, CAOs are left trying to keep the doors open to students from disadvantaged backgrounds. Mr. Miles stated, "We have to build pathways so that if a student is coming from an institution that maybe doesn't have all the socio-economical advantages and resources, that we have a pathway."

The recognition of disparities in access to proper math preparation was salient across the CAO responses. They discussed having conversations with school principals to strengthen their curricula and with university faculty to be more flexible about admission requirements. Mr. Miles mentioned, "We're looking at other alternative ways, particularly for whether it's low-income or students of color. Can we get them up to speed before they get here? What can we offer them? We're having those conversations in real time right now." CAOs discussed how this manifests in their application process. Mr. Gavin recalled needing to call students to discuss other options.

> We might see a student, particularly an underserved student—now, it would not be racially driven, and it never really was. It was more of a first-gen, income-driven, where they might go to one of the schools that just have math analysis or they don't have physics and apply to computer science and engineering.

Because they are not able to provide direct access to these majors, CAOs must address the compound disadvantage of low-income communities and their ability to pursue additional education. When describing the need to increase participation in a pilot summer program, Mr. Miles said, "Understanding that if they already are disadvantaged and we want them to do math and to catch up, that they probably need a summer job or need to work, and they're helping their families out." As CAOs seek to deliver on their institutional goals, these academic opportunity gaps speak directly to a significant challenge some URM applicants face when trying to gain access to STEM majors.

Relation to Other Institutions

Rounding out the environmental factors that contribute to the challenges CAOs encounter in their attempts to diversify STEM is how their institution is perceived in relation to the other college options students may have. CAOs described the way that other institutions and their

actions can have an impact on how they deliver their own admission decisions. The nature of the relationship with other institutions varied across respondents. Four of the six CAOs described the impact that another institution's admission decision timeline could have on their own selection. Mr. St. Patrick mentioned, "We don't have early decision or early action. So by the time we've done our offers, these other schools have already done their EAs and EDs." He uses this information to understand the admit and yield trends of students applying to STEM programs and to ascertain the number of students he may need to admit to hit his enrollment goals.

Dr. Taylor talked about the volume of regional public institutions across his state and the challenge it brings to recruiting broadly across the state. When describing efforts to recruit students in a neighboring county that is home to a regional public institution, Dr. Taylor remarked, "We do a lot of efforts down there, just try to convince these kids that are like, 'Oh, well, why would I go 45 minutes north when I could just go to my local university?'" The competition for qualified URM applicants to STEM emerged as the most salient factor that CAOs consider in relation to the other institutions in or around their state. Mr. Montgomery mentioned about his competitors, "Everyone else around us is buying all the marketing tools, doing all the discounts, and doing what they can to keep themselves afloat." Mr. St. Patrick highlighted,

> Our competition is another layer in all of this that helps inform the reading and, ultimately, most importantly, the shaping that takes place in the committee in thinking about the number of students that we want to ultimately provide offers to in those particular programs.

Summary

CAOs recognize many challenges in diversifying the STEM pipeline. While the CAOs described specific challenges, most can be categorized as either institutional or environmental. The institutional and environmental factors that the CAOs outlined do not exist as a separate set of issues but rather as a collaboration of contributors to the challenges in the URM pipeline to STEM. These multi-layered factors showcase challenges for URM students in their high schools, the universities they are applying to, and the states in which they exist. Understanding that these challenges are both institutional and environmental starts to provide insights into the nuances and complexities of the STEM pipeline and its inaccessibility.

This misalignment of institutional values and K–12 experiences requires CAOs to be educated on the systems they navigate and represent in order to find opportunities to provide URM students access to STEM majors. The next research question seeks to understand how CAOs are able to meet these challenges and provide that access.

Chapter 7: The Hidden Hand in College Admission: The Role of the Faculty

When tackling the challenges and strategies outlined by CAOs in this study, it became clear that navigating university faculty was a crucial institutional factor that stood out from the rest. In the second finding, CAOs highlighted the significant impact that faculty members have in determining admission outcomes and how their relationship with faculty directly affects their ability to implement strategies to overcome the obstacles they face. This chapter describes how the respondents described university faculty's influence on the admission process and how CAOs work with them to reduce barriers in the pipeline.

In Table 6, provides a snapshot of the key theme and sub-theme of faculty that emerged from the conversations and that will be discussed and evidenced in this chapter..

Table 6
CAOs Describe the Role of Faculty in the Admission Process

Theme & Sub Themes	Description	Participant Example
Faculty Involvement in the Admission Process ○ Setting Policies & Guidelines ○ Educating Faculty on the Admission Landscape	Participants describe the faculty's influential role in determining the admission criteria and outcomes.	"Our academic units, they [faculty] establish those guidelines as far as what are the things that students need to have in order to meet the minimum standard to be considered for their academic program." —Mr. St. Patrick, Redwood Central University

In the semi-structured interviews, CAOs highlighted that university faculty members wield substantial influence over college admission policies and practices. The CAOs underscored that their faculty are a decision-making body with the power to shape admission criteria. Furthermore, the CAOs unanimously emphasized sensitizing faculty to the K–12 education landscape impacted by these criteria.

Setting Admission Policy and Guidelines

When discussing both internal factors that impact admission and strategies around nuanced evaluation, all of the CAOs described the role of faculty in setting admission policies and guidelines. This role of faculty has historic roots that pre-date the college admission profession. Dr. Taylor explained, "Because the division of enrollment management didn't exist until two years before I got here, every college felt that they were responsible for recruitment for representation in their class." These faculty committees set guidelines on admission criteria and even selectivity. Mr. St. Patrick explained, "The overall number of students, first-year, transfer, main campus, regional campuses, they're established with the information we get from the academic schools and colleges." Typical of all of the CAOs' experiences, respondents spoke about the role of faculty in setting admission guidelines and policies. Mr. St. Patrick expounded:

> Our academic units, they establish those guidelines as far as what are the things that students need to have in order to meet the minimum standard to be considered for their academic program. And then, admissions, we do the interpretation of the policy, and we do the full read of the application, and we do the reading for all first-year and transfer applications, not only for the main campus but for our regional campuses as well.

When describing shared governance, Mr. Miles mentioned, "Our faculty senate really charged admissions to make admissions decisions. But I think there's sort of a renewal of interest in the overall admissions process, particularly post-pandemic." Whether it is the evolving landscape around standardized testing, the disruption of learning loss, or responding to the most recent Supreme Court decision, CAOs described how critical their engagement with faculty is when determining admission criteria. When describing how he engages with some of the deans of the colleges at his institution, Mr. Montgomery explained:

> [Faculty] set those standards like who gets admitted. I would even say with some merit scholarships, there's definitely work with the council of deans to get their approval on things with our budget and how we've done some test-optional things. There's approval that's brought that way, but it's really only a handful of programs that are highly selective and those faculty are making those decisions ultimately, for the most part. The deans approve, "All right, these are the standards." And then they leave admissions to do the evaluations and use those standards as a guide on who to admit or not to admit

Mr. Montgomery went on to clarify that in more selective majors like nursing, "All those decisions are made at a faculty committee level." Dr. Taylor supported this claim when he described the additional admission requirements to the College of Engineering: "The central admissions office will meet with the engineering faculty to finalize that criteria." The faculty of selective majors and colleges often set the admission criteria, including the additional admission requirements discussed in the last chapter. CAOs must engage faculty around these additional admission criteria to provide access to selective majors. When discussing additional admission requirements, Mr. Miles explained:

> Our business school has seemed to be more flexible if you come in without having the prerequisite math, but obviously wanted to get you there. Engineering? Not quite as flexible, but we're looking at other alternative ways, particularly for whether it's low-income or students of color.

CAOs described the need to work with and around faculty admission criteria to provide URM students access. However, the keeping of a tight hold on the more selective majors resonated across the CAOs in this study. Ms. Green described working with the School of Business faculty about their additional admission requirements: "I also get the sense that it's a major that likes the elitism of it all. So, they're not motivated necessarily to bring the barriers down." Mr. Miles described meetings with faculty of his selective colleges as "going up against folks who don't necessarily understand or want to understand and maybe have their own self-interests at play versus . . . understanding what's best for our communities and growing the institution." When working with the faculty of selective admission majors on admission criteria,

CAOs navigate the tension of employing the additional admission requirements faculty desire and their equitability given the experiences of the applicant pool.

Educating Faculty on the Admission Landscape

As respondents described faculty as the ones who ultimately decide admission criteria, CAOs described the importance of their relationship and particularly their role in educating faculty on the admission landscape and the potential or realized impact of the criteria they suggest. CAOs described that even the faculty who care about admissions, access, and equity are often unaware of who or how people may be impacted. When discussing how knowledgeable faculty are on the admission process, Mr. Gavin explained, "They're on panels, things of that nature. There are groups that are interested in admission. I spoke with a subset of the faculty senate not too long ago. But broadly speaking, less than you'd think." With CAOs needing to deliver on institutional enrollment goals and navigate the desires of the faculty, they recognize the need to educate institutional partners on the evolving landscape of the applicant pool. Mr. Miles described this duty:

> Really understanding that while the issues don't change, the people do, and really their understanding of the issues. And so there's challenges everywhere. And how do we communicate in a way to get people to understand, to persuade people, quite frankly, to understand where you're coming from and why it's the best thing for the institution to move in the direction you know that we should be moving into.

Additionally, CAOs described the danger of faculty making uninformed or poorly informed decisions around admission criteria. Mr. Montgomery explained:

> Based on some conversations I've had with some deans and associate deans and faculty, I would be shocked if they were able to look at a high-school transcript and have any intelligent understanding of, "This is a high-flying student at this school that didn't have an opportunity to take AP this or AP that, or physics."

When describing the role of the CAO in these interactions, Mr. Miles underscored, "It's about educating, and as a leader, being able to communicate effectively in a way that folks understand." Mr. St. Patrick supported this in his responses when he talked about trying to get faculty to embrace holistic review and allow for flexibility around their requirements. When trying to shift the mindset of faculty, Mr. St. Patrick explained how he had faculty engage directly with communities that their decisions would impact:

> We had to get some school counselors, for instance, to be able to come in and talk to them [faculty], and get them to understand some of the difficulty in students even being able to take those courses at some of those under-resourced schools.

The relationship CAOs have with faculty is crucial. As the national conversation is beginning to emerge around reinstating standardized testing requirements following the moratoriums put in place due to the COVID-19 pandemic, CAOs discussed the need to educate faculty on standardized testing as an evaluation tool. Mr. Miles shared his frustration when he expressed that his school has

> [. . .] faculty that want to go back to requiring the SAT because they're seeing the impacts of students not doing quite as well because of lost learning. And they have correlated that with, well, if we require tests, then everything will be fine again, which is totally absurd. But we've got to show them the data.

Responding to faculty about current trends or hot topics around admission was described by CAOs as a significant function of their role. Mr. St. Patrick also had to discuss standardized testing with his faculty committee. To help faculty understand the equity issues with relying on the SAT for admission, he shared, "We showed them that you can look at the average scores of different populations and show that there are discrepancies in these scores of Black and Brown students compared to White and Asian students." It was clear when concluding my conversations with them that CAOs believe the role of educating faculty is one of the most essential functions of their work and critical to their ability to increase access to STEM majors.

Summary

The dynamic of a powerful, relatively uninformed decision-making group is an emergent challenge for applicants to STEM majors that CAOs described in their responses. How CAOs work to create access to STEM majors is described in the next chapter, but this important body is often unknown to applicants or the public. Faculty are not questioned by the public about admission criteria or requirements despite the responsibility they have in constructing these pathways. Shedding light on this group and their influence is a powerful finding to help provide greater insight into the decision-making that contributes to college admission and particularly to STEM admission. In the next chapter, I highlight the strategies CAOs employ to address these challenges and those from Chapter 6, and create opportunities for URM students to access STEM.

Chapter 8: Leading With Purpose: CAOs Meeting the Moment

Navigating the tensions described in the previous section, CAOs are in a unique position to disrupt the prevailing outcomes of inequitable participation in STEM majors. Staying true to the ethos of Harper's (2010) anti-deficit theory, I asked participants to discuss the ways they are successful at providing access to STEM majors for URM students despite the challenges. The third and final major finding of this research inquiry is that in order to ameliorate the multilayered access challenges for URM students to STEM, CAOs employ three similar strategies to create access to STEM: investing in pipeline development and values-based recruitment, committing to nuanced and holistic evaluation, and embedding equity values with staff. Mr. St. Patrick described the important ways to meet the moment and these challenges by saying,

> That involves the building up the pipelines and the pools of students, developing the admissions policy, the training and the operations of the application review, the yielding of students, the behind-the-scenes operations and systems, the engagement relationships with our internal campus stakeholders and our external campus stakeholders.

This comprehensive approach was supported and described by the various CAOs in their responses.

In Table 7, provides a snapshot of the key themes and sub-themes that will be discussed and evidenced in this chapter.

Table 7

CAOs' Strategies to Provide Opportunities for URM Students to Access STEM

Theme & Sub Themes	Description	Participant Example
Pipeline development ○ Values-Based Recruitment ○ Counselor Engagement ○ Summer & Bridge Programs	Participants describe the importance of engaging in pipeline development and recruitment practices that align with the experiences and challenges of students underrepresented in their applicant pool.	"So we know that there's some challenges K through 12. And so understanding the data and knowing the landscape. And so then I think as the public or as the flagship for the state, as a public good, I think we have, really, responsibility to do what we can to help." —Mr. Miles, Harmony University
Nuanced Evaluation ○ Holistic Review & Correlation to Student Success ○ Alternative Admit Pathways	Participants describe how their approach to evaluating applicants contributes to outcomes of greater diversity in STEM majors.	"Allows the reader the latitude that if they're doing their review, and they feel that based on the context of the application and the other information that they have the opportunity to make that evaluation on an applicant and to not hold against them that they don't have certain required courses." —Mr. St. Patrick, Redwood Central University
Embedding Equity Values with Staff ○ Hiring & Educating Practices ○ Setting Organizational Culture	Participants explain how they create conditions for their staff and admission office to approach admission work with an equity lens.	"Discuss a book, discuss articles, discuss podcasts, and let's talk about some of the issues in higher education as they relate to DEI and then what our role is in the office." —Mr. Montgomery, Horizon Hills University

Pipeline Development

To address the institutional challenges of the public flagship mission and the environmental challenges of the state context described earlier, CAOs recognized the need to understand the lived experiences of their applicant pool. Participants indicated that strategic pipeline development and values-based recruitment were critical in addressing the varied educational experiences that impacted prospective STEM applicants. Excavating the values that inform the public flagship mission, CAOs are confronted with the challenge of providing access to all of the diverse educational environments their applicant pool represents across the state. When recognizing the varied educational experiences of students in their respective states, all respondents spoke of a responsibility to engage underrepresented communities to provide access to their respective institutions. Prior to that engagement, they must educate themselves on the happenings in those communities. Mr. Miles explained,

> So we know that there's some challenges K through 12. And so understanding the data and knowing the landscape. And so then I think as the public or as the flagship for the state, as a public good, I think we have, really, responsibility to do what we can to help.

When describing pipeline development practices, CAOs described the importance of values-based recruitment, engaging with college counselors, and summer bridge programs in their work to diversify STEM.

Values-Based Recruitment

All of the respondents spoke to the importance of engaging in values-based recruitment in line with their public flagship mission to be accessible to as many students in their respective states as possible. Mr. Montgomery mentioned, "It's more important than ever now that we have to really reinforce this message that you belong here and there's a place for you here. And you can do this." Values-based recruitment is when CAOs have recruitment strategies that are designed to increase prospective student engagement with the groups that are missing from their applicant pool, either in quality or quantity. The target population is often tied to the institutional mission or admission strategy. When describing the ways to diversify STEM, Mr. Montgomery explained,

> I think so much of what we would consider our DEI mission as an admission office has to do with a lot of the other things that go beyond application review. It's spending a lot of time in underserved communities doing college nights, and doing programs.

When values-based recruitment intersects with a public flagship mission, CAOs described the need to consider those missing from their application process. Mr. St. Patrick explained,

> We're doing outreach to those particular high schools that have a larger number of students from underserved pipelines, or schools that are more under-resourced or larger numbers of those students that are coming from bad neighborhoods that are more adverse.

To execute values-based recruitment, CAOs described the need to both learn about and educate these target populations differently than those in more resourced education environments. They described using research tools, such as the College Board's Landscape, to better understand the experiences of their applicants both in school and at home. This new information has helped CAOs identify ways to adjust where and how they engage. When describing the new engagement tactics of a regional recruiter in an underrepresented part of the state, Dr. Taylor exclaimed, "It is exactly the way that we need to be talking to families who are intimidated by higher education, by Central Highlands University and stuff like that."

Counselor Engagement

When describing pipeline development, CAOs discussed the need to address the realities of URM students and their access to STEM. This includes engaging with the counselors that are in those communities. When engaging in values-based recruitment, Mr. Gavin discussed the importance of building relationships: "We meet with the counselors and the principals, just to hear from them about what's going on." These relationships become key when evaluating

students, as admission officers become much more informed on the education environments these students are coming from.

Additionally, CAOs talked about utilizing their relationships with counselors to inform faculty of the challenges in the admission criteria. Mr. St. Patrick explained,

> We had to get some school counselors, for instance, to be able to come in, and talk to them, and get them to understand some of the difficulty in students even being able to take those courses at some of those under-resourced schools.

This education for faculty is to encourage more inclusive admission criteria that consider the experiences and environments of all the students in the state. The major challenge that CAOs described about counselor engagement was the high turnover of professionals in the role. Dr. Taylor mentioned, "There's so much turnover with those counselors, so it's just making sure we're doing tons of education and updates for them, all year round, not just once a year." The importance of these relationships resonated in the responses of all CAOs in the study.

Summer and Bridge Programs

Respondents highlighted specific initiatives around summer programs and bridge programs as examples of strategic pipeline development. CAOs described pipeline development as engaging with students before they enter the applicant pool and before they are exposed to the freshman curriculum to address gaps left by varying academic experiences; they described it as a strategy to get URM students to be as competitive as their more resourced peers. CAOs discussed engaging communities through bridge programs and summer programs to build greater capacity for students in the areas they may be lacking because of their school offerings. Mr. St. Patrick said,

> We established a pipeline program for current juniors and rising seniors, where we bring underrepresented students to our campus for a week-long summer enrichment program to, again, get them on our campus, meet with our students, with our faculty [and] staff. Again, as a pipeline building.

This was supported by remarks by Mr. Miles, who mentioned "right now working with the math department and coming up with a math boot camp in the summer for students who are interested in coming to Riverdale State University."

CAOs also discuss the opportunity that bridge programs provide to ameliorate the different experiences of their applicants. When describing a summer bridge program for STEM students to address math preparation, Mr. Montgomery explained that even if students were exposed to certain math elements, "It may have been taught on point or taught in different ways. There's been some interventions in that way to really try to help students." Acknowledging the lived experiences versus the expectations for students allows CAOs to be advocates of bridge and summer programs when trying to build representation in the STEM pipeline. Mr. Gavin explained,

> So they do have some summer programs primarily designed for first-generation or low-income students. But our bridge program, so to speak, for sneaking calculus under their belt or pre-calc or possibly physics—because of this, we do admit kids without physics.

Mr. St. Patrick supported this when he remarked that his engineering bridge programs are for "those students who had the ability but probably needed a little more support when they came to the institution."

Values-based recruitment, counselor engagement, and summer bridge programs are the strategies CAOs described for creating a pool of admission candidates that can deliver on their institutional missions and enrollment goals. These strategies also combat the challenges of the varied educational contexts of prospective students in the state and address the challenge of the public flagship mission described earlier by the CAOs. To engage the underrepresented populations, institutions must address the gaps in information and exposure of students and educators in those communities. CAOs all discussed the importance of engaging with students before they enter the applicant pool and of addressing the gaps in academic exposure that could hinder these students' success, particularly in the areas of math and science. All of these efforts get students into the applicant pool. However, CAOs also describe the need for nuanced evaluation to take place in order to align the outreach efforts with actual admission decisions.

Nuanced Evaluation

When describing their respective undergraduate admission evaluation processes, CAOs discussed the need to be mindful of the varied opportunities for students in their applicant pool. The evaluation process is where CAOs describe opportunities to address the institutional challenge of additional admission criteria for STEM and the environmental challenge of academic opportunity gaps. Based on information gained through deliberate recruitment practices, CAOs began with two essential characteristics of their evaluation process: a commitment to conducting a holistic review process and correlating admission data to student success at their individual institutions.

Holistic Review and Correlation to Student Success

Holistic review was described by many of the participants as an evaluation that is determined not by a student meeting a standard bar of achievement that is placed on the entire applicant pool but instead by contextualizing student achievement within the academic environment and opportunities available to them. CAOs described the current instruments being used to evaluate students as inadequate to simply serve as a rubric for determining admissibility to their respective institutions. When discussing the effort to go test-optional, CAOs described how they were employing an unconventional approach to evaluation for themselves. As Ms. Green explained, "We were so trained to believe that [standardized test] scores correlated with merit." This was supported by Mr. St. Patrick, who went further to describe how his institution came to the conclusion that becoming test-optional made sense. "We pulled the data that showed that for the overwhelming majority of our students, the test score itself was not a predictor to students' performance their first year."

CAOs mentioned that ensuring staff members have expertise on the lived experiences of their applicants is critical. Mr. Gavin described the evaluation structure at Riverdale State University:

> We read by territory, and why we read by territory is for our readers to understand intimately the nuances, the differences, the offerings that are available at a particular high

> school, and to have that familiarity with the school so that they can utilize proper context in the evaluation.

This commitment to holistic review provides admission professionals an opportunity to leverage their learnings to ensure an equitable evaluation. Mr. St. Patrick described that holistic review

> [. . .] Allows the reader the latitude that if they're doing their review, and they feel that based on the context of the application and the other information that they have, they have the opportunity to make that evaluation on an applicant and to not hold against them that they don't have certain required courses.

Moving the faculty beyond the strict admission requirements to a more holistic approach to admission considerations requires significant education of the faculty. CAOs found the most compelling argument when addressing faculty was a correlation to student success for students once on campus. CAOs all mentioned the importance of their rating systems doing what a cross-tabulation of GPA and test scores could not do—truly correlate to student success. According to Mr. St. Patrick, the most persuasive arguments when addressing faculty was a recalling of the institutional priorities and a correlation to student success. He said, "We were able to show them, based on our ratings of students, how we're able to correlate to student success predictability." CAOs described the ability to evaluate in this manner as much more equitable and responsive to their diverse applicant pools to STEM than non-holistic evaluation.

Committing to student success also requires CAOs to be mindful and considerate about the role advising and other campus resources play in the success of students. When describing the impact of making more holistic admission decisions, Mr. Gavin said, "We don't want to set them up for failure." Mr. Montgomery described his confidence in his holistic review process:

> I think [we] have been well-equipped to serve students that are college-ready, but that may need a little bit more backend support, supplemental instruction, tutoring, other types of programming, just to help make sure that they're on the right track to success.

In their responses, CAOs described the need to keep communication open between themselves, faculty, and advisors to ensure students have the ability to make up deficits that may be present due to a lack of academic opportunity or exposure.

Alternative Admit Pathways

Another strategy employed by CAOs in the evaluation process was the development of alternative admission pathways. For students who may be lacking in math or science prep that applies to selective STEM majors, CAOs have exercised alternate admission pathways to provide access to students in supportive spaces that will address a lack of academic preparation.

Tied to the strategy of correlating admission decisions to student success, Mr. Miles explained, "We're looking at other alternative ways, particularly for whether it's low-income or students of color. Can we get them up to speed before they get here? What can we offer them?" The alternative pathways are designed to be softer landing spots for students interested in STEM, who align with institutional priorities, and who are believed to be in need of additional support as they adjust to the collegiate STEM curriculum. Ms. Green described these pathways as opportunities for the STEM programs to ensure "whoever they bring from a pre-engineering

stage to engineering has what they need to keep them here." While there were slight variations among respondents, Dr. Taylor summarized how alternative admit pathways work:

> They apply to engineering, they can either be directly admitted to the engineering school, or admitted as pre-engineering. Which is hard because, honestly, the only difference is the restrictions they put on students, on what courses that they take at the beginning.

Dr. Taylor described the restrictions in the pre-professional programs. He explained that students have a much more rigid curriculum to ensure their progress. The pre-professional programs prescribe required courses to ensure participants are ready to engage with the rest of the major requirements upon completion. Mr. Montgomery described a similar pathway for students at his school: "You could be admitted pre-nursing here and then take these prerequisite courses at Horizon Hills and then try again through what I think . . . what is called our standard path of admission."

Alternate admit pathways are not just pre-major programs but can also include admission to a satellite campus. Both Mr. Miles and Mr. St. Patrick described satellite campuses as homes to some of these pathways and pre-major programs. Mr. St. Patrick described his satellite campuses as having admit rates that are double that of the main campus, making them more accessible for URM students. These alternative admit pathways are an important tool for CAOs to diversify STEM. Mr. Miles was emphatic when he stated, "If we don't create pathways, then we are never going to increase those populations. It's just that simple."

CAOs described employing these strategies when addressing the institutional challenges of additional admission criteria for STEM majors and the environmental challenges of the academic opportunity gaps in their respective applicant pools. Mitigating these differences in the applicant pool is essential, and it establishes a version of merit that is informed by institutional success and contextualized by its applicants.

Embedding Values in Staff and Organization

Recognizing that the CAO would not be the admission officer visiting the high schools and would not be the admission officer evaluating most of the applications, the final resonant strategy involves distributed leadership. CAOs described the importance of embedding their equity values in their staff and organization. Following the Supreme Court's decision to ban affirmative action in college admissions, many CAOs spoke about the importance of building equity-centered values in the admission offices. When describing his staff's response to the decision, Mr. Montgomery said, "I think we're starting this admission cycle with the understanding that my job has never been more important than it is right now." When discussing the investments CAOs made in their staff, hiring and educating staff, along with setting organizational culture, emerged as dual foci for creating the conditions for their staff to embody an equity-focused approach to admission.

Hiring and Educating Practices

As they described hiring and educating staff, CAOs described embedding their values in the hiring process. Mr. Gavin said, "It's hiring and making sure people understand what we do and what we value, and how they can contribute and hopefully be fulfilled in what they do." This sentiment was supported by Mr. St. Patrick's description of his office as one with a "commitment to diversity and inclusion, not only from the students that we're bringing in, but

from our culture is something that we emphasize in the recruitment of staff and the interview process."

The CAOs described their roles as educators for their staff. Beyond ensuring equity and inclusion values are embedded in staff training, they spoke to keeping the conversations current throughout the cycle. Mr. Montgomery spoke to his commitment to lifelong learning as he encourages his staff to "discuss a book, discuss articles, discuss podcasts, and let's talk about some of the issues in higher education as they relate to DEI and then what our role is in the office." This also included ensuring staff are up to date with innovations in the field of college admission. "The staff needs to be empowered to be in better places," said Ms. Green.

Setting Organizational Culture

*CAOs listed s*etting an organizational culture was one of the most important strategies. Mr. St. Patrick explained,

> Whether it be the recruitment of students, whether it be the messaging that we have for students, whether it be how we read applications, whether it be our behind-the-scenes system, is that ensuring that all of our associate directors are leading and implementing through a diversity inclusion lens.

Layering these values in all parts of the work enables staff to understand how to move from theory to practice. Mr. St. Patrick went on to say, "It's the regular touch points, regular meetings with the associates, individually, with the associate team, and then with all of our managers to make sure that there is clarity of understanding what the expectations are." All CAOs focused on the importance of ensuring the values and understandings around equity and inclusion permeated all other leaders within their organization.

Mr. Montgomery explained how important setting organizational culture is to him as a leader. He described "creating a work environment where people can take their work seriously and appreciate the high calling of the work that we have." Again, this urgency and importance of building like-minded leaders resonated across all of the participant responses. This was supported by all the respondents and best summarized by Mr. Miles, who said, "If I can get the culture there, then that will live on. And that's what inspires me, and that's what keeps me going and gives me hope."

Summary

Despite the many challenges, CAOs work with universities to create opportunities and access to STEM majors for URM students while trying to safeguard URM students from being left unsupported once they enroll. CAOs believe the tools often used to evaluate the different educational experiences are inadequate. As described, CAOs have developed strategies to address internal and external challenges URM students face in the STEM pipeline. The strategies employed by CAOs to address the K–12 inequitable landscape are values-based recruitment and pipeline development focused on academic opportunity gaps and institutional priorities; a commitment to a nuanced, holistic evaluation process to account for inequitable academic opportunity that is focused on student success; and the cultivation of a staff and culture that centers equity and inclusion values in all facets of the work.

These strategies attempt to address internal and external forces that make it difficult for URM students to pursue STEM majors. CAOs' most salient strategies, like values-based

recruitment and counselor engagement, were those that were within their locus of control. Other strategies, such as correlating evaluation to student success or developing alternative admit pathways, require educating faculty and campus administrators on how or why admission standards may be inadvertently leaving out a population or ignoring the experiences of another. Working together, educators can construct institutional strategies that address the systemic failures that lead to the misrepresentation of URM students in STEM majors at various institutions. All respondents indicated that the internal and external forces must be addressed simultaneously to provide greater access to STEM majors for URM applicants.

Chapter 9: Discussion and Implications

This study explored the ways in which CAOs understand and respond to the misalignment of college admission requirements to STEM and the high-school experiences of their diverse applicants. This chapter offers a summary of this study's findings and puts them in conversation with the previous research on the STEM pipeline and college admission. Following the summary of the findings, I present the discussion in themes that connect the participant narratives to the literature. I also provide implications for practice and future research.

Discussion of the Findings

This study is a multiple-case study (Yin, 2018) to explore how CAOs provide URM students access to STEM majors despite the challenges these students face in the admission process. The research questions this study explored were (a) how the case CAOs characterized and analyzed the challenges that URM applicants face in the admission process to STEM majors and (b) what strategies CAOs employ to overcome these challenges and provide access to STEM majors for URM students. To address these questions from the qualitative data collected at the six institutions, I explored various data sources, including a leadership questionnaire, semi-structured one-on-one interviews, and an examination of institutional websites and publicly available data.

I focused on CAOs' experiences in their role in addressing the challenges of the STEM pipeline. I chose to engage CAOs at R1 public flagship institutions to understand how professionals navigate the tensions of the foundational institutional mission of access and the exclusion to STEM majors that the academy constructs. Gathering the perspectives of these leaders was vital, as they occupy the intersection of high-school and postsecondary education. In order to best analyze the impact of the challenges of the STEM pipeline and the strategies CAOs employed, I utilized CRT in education (Ledesma & Calderón, 2015), Sean Harper's anti-deficit framework (2010), and Walton et al.'s (2013) affirmative meritocracy.

Upon the completion of the research, three significant findings emerged. For the first finding, CAOs characterized the challenges for URM students in the STEM pipeline as both internal and external to the institutions in which they worked. Internal factors recognized as challenges included delivering the public flagship mission, responding to current and evolving enrollment goals, and the additional admission criteria for STEM applicants. Together these forces create pathways that, at best, make it difficult for URM applicants and, at worst, deem them ineligible to participate in STEM majors.

These challenges compound when considering the additional external factors that emerged as challenges for URM students in the STEM pipeline. These factors are external to the institution but describe the context in which students apply to college. The external factors that came into focus were state context and initiatives, academic opportunity gaps, and the institutions' relation to other universities around them. These layered and compounded challenges construct a pathway to STEM majors that contributes to the current underrepresentation.

The second significant finding was the determinative but oftentimes overlooked role the faculty of an institution has in establishing admission criteria and guidelines. The role of faculty emerged as the respondents talked about challenges and strategies to provide access to URM students interested in pursuing STEM majors. While the literature provided some information

about faculty involvement in recruitment, there is a lack of research on the role of faculty in setting admission policies and guidelines. Throughout this study, the role of faculty was present in CAOs' explanations of where institutional challenges originate. When discussing faculty, two aspects of their relationship with CAOs and the admission process emerged as significant. The first involves the role faculty play in setting admission policies and guidelines. CAOs offered insight into how faculty broadly construct admission policy, specifically for STEM majors. CAOs described their frustrations as, often, these policies are void of any understanding of the experiences of the applicants and create significant barriers to admitting URM students. To address this, CAOs discussed the importance of consistent education of faculty on the admission landscape in order to ensure they are aware of the potential impact their admission policies and criteria may have.

The third significant finding of this study provided insight into the strategies CAOs employ to provide URM students access to STEM majors despite all of the aforementioned challenges and barriers. In order to ameliorate the multilayered access challenges for URM students applying to STEM, CAOs employ three similar strategies to create access to STEM. The first is investments in pipeline development and values-based recruitment. CAOs discussed the need to better engage with underrepresented communities in their outreach, engage gatekeepers and influencers like college counselors, and provide summer and bridge programs to ameliorate gaps in their academic exposure to ensure success. The second strategy is committing to a nuanced approach to evaluation that is grounded in holistic review, correlates to student success, and provides alternative pathways to admit students who may be lacking the proper prerequisites due to academic opportunity gaps. The third is to ensure that their values are embedded throughout their organizations. For this, CAOs described the importance of setting organizational culture and communicating values in the hiring process and repeatedly throughout the admission cycle.

Upon analyzing the findings, I identified the following two themes, which I hope to amplify with this research. The first theme is the continuity of the culture of exclusion that informs faculty and the norms of the college admission profession. The second theme is the utility of Walton et al.'s (2013) affirmative meritocracy in resisting the exclusive culture of college admission to provide greater access for URM students. My exploration of these themes will provide my perspective on this study's findings and their relationship to the literature and the work of college admission practitioners.

The Evolution of Exclusivity

Revisiting the idea that American higher education was founded around the mission to serve society and promote democracy (Benson et al., 2007), I presented the original frameworks around college admission in Chapter 2. Snyder (1993) contributed that at the nation's first college, one-fourth of students were rejected because of deficiencies in Latin, Greek, or sometimes mathematics. In relation to this study, the requirements of higher-level math and science, despite inequitable access in K–12 to these subjects, is reminiscent of the Greek and Latin admission requirements of Harvard College. In both instances, these requirements are less about measuring the potential to succeed and more about determining merit based on prior educational environments inaccessible to all. It should, therefore, be concluded that the idea of creating exclusivity around educational experiences has endured the test of time.

The study focused on URM students accessing STEM majors with Ledesma and Calderón's (2015) framework of CRT in education applied as an analytical tool to connect the

research to the findings. CRT in higher education posits the need to challenge notions of race-neutrality, objectivity, and ahistoricalism (Ledesma & Calderón, 2015). Upon review of the literature, it was clear that higher-level math and science courses are essential to persist in STEM in college (Tyson et al., 2007), and that Black, Latinx, and low-income students have disproportionate exposure to AP STEM courses (Kolluri, 2018; College Board, 2014).

In this study, CAOs described the impact of this lack of exposure, often due to a lack of access to academic opportunities, when it collides with the additional admission requirements to STEM majors as a challenge for URM students in the application process. Oakes and Guiton (1995) contributed that URM students also have fewer opportunities to take the critical gatekeeping courses that prepare them for science and mathematics study after high-school—algebra and geometry in junior high school and calculus in senior high school. While these additional admission criteria were determined by university faculty, CAOs explained that applicants without the AP and other higher-level math or science courses are often considered to be ineligible for consideration to the STEM majors.

The CAOs described the majority of students who have less access to rigor as Black, Latinx, and low-income students across their state. CRT in education aims to demonstrate how postsecondary institutions perpetuate whiteness by reifying discourses that privilege normative conceptions of who students are and what successful students look like (Ledesma & Calderón, 2015). Despite students having met overall admission criteria, CAOs stated that those who do not meet the additional admission criteria for STEM are considered to be underprepared by the STEM faculty. This finding is supported by Iverson (2007), who explained that these assumptions allow for students who do not have the experiences or resources, particularly students of color, to be categorized as "disadvantaged" or underprepared and, therefore, defective. URM students who enter STEM majors at selective college environments where they are expected to fail in the major will fulfill this prophecy in droves (Bonous-Hammarth, 2000). Despite the fact that their circumstance and not their ability often defines their preparation, this labeling requires CAOs to find other pathways to get URM students into STEM majors.

When examining the public education system, what does it mean that a student can meet all of the requirements of one level of public schooling (high school) just to be told they are unqualified or unprepared to participate fully at the next level of public schooling (college)? Harper (2010) offered that when employing CRT, failure to acknowledge the racial impact is an injustice to critical race scholarship. The evidence from the research and this study suggest that, while appearing to be objective, the admission criteria specific to STEM majors are demonstrably discriminatory and can be considered racist. STEM has been marketed to individuals as a lucrative field of study in college, as graduates who major in disciplines such as engineering and computer science, on average, earned more annually and over a lifetime than those who specialize in any other fields (Arcidiacono, 2004; Carnevale et al., 2011; Langdon et al., 2011). Questioning the system and its outcomes becomes even more resonant when discussing academic areas that have the greatest potential to create social mobility.

Effectively maintained inequality theorizes that as participation in particular levels of school approaches saturation, dominant groups maintain inequality by ensuring exclusive access to distinctions within the saturated levels (Lucas, 2001). Despite the fact that all but one of the colleges have an average admission rate of 67% or higher, including one institution having an admit rate of 95%, access to STEM majors is still far more exclusive. CAOs described the lack of ability for URM students from low-resourced high schools to meet these additional admission requirements. They shared their knowledge of communities and schools that did not have access

to the higher-level curricula required to be considered for admission to STEM majors at their institution.

Upon reviewing the findings of this research, the additional STEM admission criteria that are out of reach for many Black, Latinx, and low-income students are currently a tool to effectively maintain inequality. Together, the established literature and this study argue that as URM students participate in higher education at greater levels, STEM admission and the STEM pipelines are institutionally developed tools that effectively maintain inequality. Most importantly, the maintained inequality is not just in relation to what people cannot study but what industries they cannot access beyond graduation. These structures of exclusivity have evolved since their origins at Harvard College, but the outcomes remain: separate educational pathways for the privileged and underrepresented that can be overcome but are designed for URM students to fail.

Affirmative Meritocracy in Action

Harper (2010) posited that those who endeavor to improve student success in STEM would learn much by inviting those who have been successful to offer explanatory insights into their success. The anti-deficit framework influenced this inquiry by centering the voices of those who have been able to achieve in providing access for URM students to STEM majors despite the many factors and forces that encourage them not to. It is noteworthy that in an industry like college admission, whose culture was founded on exclusion and exclusive practices, approaching admission from a framework of college access can be considered a form of resistance to the system's design. It is with this characterization that CAOs' strategies should be understood.

One of the most important strategies CAOs described to admit URM students to STEM was a commitment to holistic review. Affirmative meritocracy suggests that most tools to measure merit are biased or unfair, and in order to use them, CAOs have to account for the disproportionate outcomes provided by their assessments (Walton et al., 2013). The CAOs explained that in order to properly evaluate their diverse applicant pool, they needed to ensure they were looking at more than a GPA or test score. As increasing diversity emerged as an enrollment goal, CAOs explained why it was important to have an evaluation process that is more flexible to the lived experiences of the students in their applicant pool. CAOs described the importance of committing to holistic review and contextualizing student academic opportunities in their evaluation.

In their responses, CAOs argued that relying on standardized test scores can be problematic for the underserved populations they are seeking to increase. Alon & Tienda (2007) suggested that using standardized tests as a basis of admission notably benefits those with more resources and power to influence how merit is defined while disadvantaging others. In addition to adopting a holistic review, the CAOs described the importance of correlating their metrics to student success on their respective campuses. This renewed definition of merit is one that is more accessible and more practical than a more rigid matrix or rubric to determine admission. The framework of affirmative meritocracy allows admission professionals to challenge the tools we use to define merit (Walton et. al., 2013) and develop metrics that are more indicative of the diverse experiences of our applicant pools.

In order to effectively employ the affirmative meritocratic holistic review, CAOs described the need to engage in pipeline development and values-based recruitment to seed a diverse applicant pool and to inform designations of merit in the admission process by student

success at their respective institutions. Engaging with counselors and establishing summer and bridge programs are two tactics within that strategy.

In their responses, CAOs described engaging with college counselors as important to educate faculty on the experiences of the students they serve and the educational resources those students have at their disposal. CAOs described these engagements as critical to getting faculty to understand the impact of their admission policies on communities across the state and nation. Engaging with these counselors is not just for the sake of CAO and faculty learning. Cabell et al. (2021) found that for URM students in STEM, high-school counselors can make a difference by exposing them to possibilities and opportunities in STEM. In order to seed their pipeline, CAOs acknowledged the important relationships they have with counselors to diversify STEM majors.

CAOs also described the importance of having summer programs for high-school students and bridge programs for new students to strengthen math efficacy and provide greater exposure to math than students had within their low-resourced high schools. This is particularly important for URM students, as summer programs provide opportunities for students to use laboratory equipment that may not be available in their high schools (Markowitz, 2004). The evidence in the literature also suggests that STEM summer program participants are likely to enroll in STEM-related majors during college (Hurtado et al., 2009; Kabacoff et al., 2013). While participation is often limited by scale and cost of the experience, summer programs are a tool that CAOs try to promote to prospective URM students to strengthen their competitiveness to STEM majors.

This study argues that, individually and collectively, the strategies CAOs discussed that provide access for URM students are examples of applying affirmative meritocracy. Aligning these efforts grounds the entire admission operation in institutional values, rewards merit within context, and is informed by student success. Affirmative meritocracy is a framework to construct all facets of the admission process with the most vulnerable in mind. It redefines merit to be more equitable by being considerate of diverse educational environments, continues to reward achievement, and is committed to student success on college campuses.

Implications

This section will describe what this research and its findings could mean for the admission and college-access profession and what further research should be conducted. The study, the relevant literature, and my professional experience inform these implications. The following recommendations are to inform future policy, practice, and research on college admission.

Implications for Policy

Considering the challenges and solutions described by the CAOs, policy changes could provide significantly greater access for URM students to STEM majors. Similar to the challenges described by CAOs, policy shifts should be considered at the state level to address the varied educational contexts of applicants and locally at the institutional level to address barriers to URM students participating in STEM. Considering the broken pipeline, state policies should address the significant misalignment of public education. Additionally, higher education must work to establish better policies to address the role of faculty in college admission to ensure they are making informed decisions when establishing admission guidelines.

Aligning Public Education. This study highlights the necessity of greater alignment between public K–12 education and public higher education. Scholars and other observers consistently stress the need to improve high school students' academic preparation to raise the overall educational attainment of the college-going population and to close gaps in attainment across groups (e.g., Adelman 2006; Perna & Jones, 2013). This is particularly important in the areas of science, technology, engineering, and math. Throughout this study, CAOs consistently described the inequity of students being shut out of programs due to the lack of rigor in their high-school offerings. Because high schools and colleges have historically developed their curricula and assessments separately, and because K–12 and higher-education governance, policymaking, and finance functions are generally not coordinated, many high schools in most states have been preparing students to receive a high-school diploma but not necessarily to be academically ready for college (Kirst & Usdan, 2009; Venezia et al., 2005). This cannot be acceptable in a society where a college degree has become a standard prerequisite to participate in the lucrative sectors of our economy. If students can succeed in high school just to be told they are ineligible in college, the definition of success in high school must be challenged.

To address this, state education departments must collaborate with K–12 and higher-education administrators on developing educational pathways specific to STEM that are available to all students. Revised policies would have a disproportionate impact on Black, Latinx, and low-income students who are currently underrepresented in the STEM pipeline.

Teach the Teachers. CAOs described the need to educate faculty on the K–12 landscape to understand how their policies could impact prospective students. Public universities should consider instituting mandatory training and term limits on faculty admission committees. If it can be recognized through the development of the admission profession that the context in which students learn can be determinative of how they present themselves in our application processes, faculty should be required to complete training to ensure they have a baseline of knowledge of the educational context their policies will have an impact on. Term limits for faculty on these committees would ensure that the representation on these committees continues to reflect the desire of the institution's senate faculty more broadly.

Institutional policies for faculty committees should consider requiring faculty to be educated on the K–12 landscape in their state and shaken from their deficit framing of students. In addition, faculty must be able to explain how admission policies are inclusive to all students in the state, regardless of academic opportunity gaps. Policies like these and greater faculty governance on these committees could be effective at ensuring that admission guidelines are considerate of all of the potential applicants.

Implications for Practice

This study and the relevant research corroborate that the underrepresentation in the STEM profession is seeded in systems and cultures of education and college preparation, not the students navigating them. In the admission profession, CAOs are able to identify challenges for URM students all along the pathway to STEM majors. This study did not discuss the challenges that the few URM STEM majors experience in a university. The strategies employed by the CAOs is representative of the thoughtful evolution of the college admission profession and a movement to try to provide access to populations that have been historically denied. When enacted together, these strategies apply affirmative meritocracy where it matters most. The simple but important premise that the tools that we use to evaluate students are inadequate to

determine merit should convince CAOs to consider these strategies to ensure equity in their evaluation and diverse representation in the pool.

Recruitment as Resistance. Values-based recruitment requires CAOs to ask who is missing from their applicant pool and who deserves attention. It differs from general recruitment, which calls for a recruitment strategy to be built from historical trends versus imagined futures. Aligning recruitment strategies to engage the most underrepresented groups in the applicant pool requires an assessment of both who they are and what they need to be successful at the institution. This is particularly important for STEM, as the disparities of access and exposure are exacerbated for URM students.

Working with college counselors, college-access programs, and principals to better understand their resources is critical to understanding what merit within context looks like. When combined with pipeline development, supplemental interventions can broaden students' academic exposure and strengthen their STEM confidence.

Make Merit Equitable. Similar to affirmative meritocracy (Walton et al. 2013), holistic review recognizes that the tools admission professionals use to evaluate students are too inadequate to be used as blunt instruments to determine merit, given the varied experiences of K–12 applicants. Holistic review requires a CAO to have a deep understanding of the applicant pool and the institution. Establishing a review process that does its best to mitigate the outcomes that K–12 produces is particularly important for public flagship institutions. No graduate of a public high school should be deemed ineligible for any major at their public university due to criteria that are unavailable to them.

A significant evolution to holistic review is the correlation to student success. CAOs described how compelling this argument was when seeking to ease rigid admission criteria or combat pressure to lift their moratoriums on standardized testing requirements. In order to correlate to student success, CAOs and enrollment leaders must have a solid working knowledge of retention and persistence. Understanding how a student's experiences prior to arriving at the institution inform their progress to graduation could be helpful in constructing equitable admission standards. This version of merit in the evaluation process provides greater consideration of a student's potential versus their achievement. When focusing on current enrollment goals, CAOs must assess institutional readiness and work with student-support colleagues to advocate for resources where necessary. Holistic and contextual assessments are essential to establish equity when applying merit and mitigate academic opportunity gaps in the applicant pool.

Admission Administrators are Educators. CAOs must have a strong relationship with faculty and understand how faculty governance works at their institution. Faculty are not admission professionals and do not spend time getting to know or understand the shifting landscape of the applicant pool. Oftentimes, faculty are also not aware of the different admission pathways and the student-support services available to help support their desires in admission. There is an expertise that CAOs must possess and teach to faculty and campus administrators just as much as they do to high-school counselors and principals. In this study, CAOs described presenting data, bringing in K–12 educators and counselors to describe experiences, and building arguments to get faculty to understand the broader impact of the admission criteria they are determining. It is imperative that CAOs work to educate faculty on college admission to align intent with impact.

Implications for Research

This study will be added to the growing research on college admission. This study will extend the research to examine the STEM pipeline and the racialized outcomes it produces. Education is a system in America that has seen dramatic shifts in a very short period of time, and more research must be done to examine how these shifts will impact an already inequitable process. Additional research must be conducted to determine the impact of (a) the COVID-19 pandemic, (b) the SCOTUS decision to ban the consideration of race in college admission, and (c) the great resignation.

COVID-19 and Learning Loss. The pandemic shook education to its core as high schools and colleges closed and set students home for 6–18 months. While a common problem for all, the research is growing to show disproportionate learning loss in more vulnerable communities. The research on the impact of COVID-19 on learning loss and student achievement is ongoing. However, it will be informative to understand how future students will show up in the college admission process. With the interest in STEM still salient and the criteria still rigid, research must be done to understand the impact COVID-19 may have on the STEM pipeline for URM students.

SCOTUS Impact. The Supreme Court's decision to ban the use of race in college admission has sent a profession that has been priding itself on diversification into a tailspin. In this study, CAOs described their concern about the ability to continue offering race-based scholarships or hosting minority-focused events, which are often signature programs and tactics to increase diverse applicants. Moving forward, research must be conducted to understand the decision's impact on the STEM pipeline and STEM participation by URM students.

The Great Resignation. Midway through the COVID-19 pandemic, the Great Resignation occurred. In 2021, according to the U.S. Bureau of Labor Statistics, over 47 million Americans voluntarily quit their jobs—an unprecedented mass exit from the workforce, spurred on by COVID-19 (Fuller & Kerr, 2022, para. 1). This is important, as CAOs described the importance of fostering relationships with other K–12 educators and the need to focus on hiring and training to embed equity into their organizational culture. With more volatility in these roles that hold much of the contextual wisdom needed for values-based recruitment and holistic review, research must be conducted on the impact this has on URM students trying to traverse the STEM pipeline.

Conclusion

The purpose of this study was to excavate inequities URM students face in the application process to STEM majors and how CAOs provide access despite these challenges. I anticipate that the essential findings and implications will initiate greater conversations and research on liberatory practices to ensure equitable participation in all parts of higher education. Explicitly characterizing the challenges and focusing on remedies was an intentional approach to codify and document proven resistance strategies for other CAOs to draw from.

There is much to be done for education in America to live up to its ideals. Public flagship institutions must lead the way, as they have the most significant provocation in their public flagship mission to serve as many diverse experiences as possible. Public education must not inadequately prepare students and then turn around and label them as deficient or underprepared. With the continued politicization and commodification of education, educators must help shape the future. Angela Davis remarked, "The challenge of the twenty-first century is not to demand equal opportunity in the machinery of oppression but rather to identify and dismantle those structures in which racism continues to be embedded" (Davis & Mendieta, 2005, p. 29). This study calls for educators to consider their agency in perpetuating or disrupting the inequity of educational pathways to STEM majors.

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Appendix A: University Admission Leadership Questionnaire

INTRODUCTION

1. Please indicate the name of your institution/system below. Please include the full name of your institution. **This information will be used solely for the purposes of determining institutional characteristics, such as sector and Carnegie Classification, in the aggregate.** Individual institution responses will remain completely confidential. No identifiable information will be shared.

   Institution/System Name:

   _____

   I am the chief executive of a campus or system (i.e., president, chancellor, or equivalent) and consent to participate in this study.

- I consent to participate in this study.

GENERAL INFORMATION

First, we're interested in learning some general information about you and your role as chief admission officer. In this survey, we use the term "CAO" to refer to deans, directors, vice-presidents and vice-provosts, and other chief admission officer positions for college and university campuses, as well as multi-campus systems.

1. Please indicate the year you began your current CAO post.

   Year: _____

2. Please indicate the month you began your current CAO post.

   Month: _____

3. My current position (Select all that apply.)

- Is an interim appointment.
- Is a CAO of a single campus.
- Is a dual role as the CAO of a multi-campus system and a campus.
- I do not have a singular campus for which I am responsible; I am the head of a multicampus system.

4. Who do you report to as the chief admission officer??

- College/University President
- College/University Provost
- Vice President/Provost of Student Affairs
- Governing Board
- System head
- Not listed (please specify):

_____

LEADERSHIP PATHWAYS

The next series of questions will ask you about your journey to your current post, as well as into the presidency/ CEO role in general.

1. Where did you hold your immediate past position to your current CAO post? (Select one.)

- Current institution
- Another higher education institution or system
- Another employer other than a higher education institution or system

2. Please list all postsecondary degrees you have earned to date):

BACKGROUND

Please tell us about you and your background.

1. What is your gender identity?

- Man
- Woman
- Nonbinary
- Not listed (please specify):

_____

2. What is your sexual orientation?

- Heterosexual
- Gay or lesbian
- Bisexual
- Prefer not to answer
- Not listed (please specify):

_____

3. Are you Hispanic or Latinx(o/a)?

- Yes
- No *(please proceed to question 5)*

4. Please indicate your Hispanic origin:

- Mexican, Mexican American, Chicano
- Puerto Rican
- Cuban
- Dominican
- Salvadoran
- Central American, excluding Salvadoran
- South American
- Other Hispanic origin (please specify):
  _____

5. What is your race? (Select all that apply.)

- Caucasian, White, or White American (non-Middle Eastern descent)
- Middle Eastern or Arab American
- Black or African American
- American Indian or Alaska Native
- Asian or Asian American
- Asian Indian
- Native Hawaiian or other Pacific Islander
- Not listed (please specify):
  _____

6. Growing up, did you hold any of the following identities? Check all that apply

- First-generation college student
- Low-Income
- Pell-eligible
- Immigrant

Thank you for your participation in this University Leadership Questionnaire.

Script	**Instructions:** My name is Femi Ogundele and I want to thank you for your time today. As an admission leader, I know your time is limited during this time of year so I appreciate you lending some of it to me. Before we begin, I just wanted to ask if you have any questions about the digital consent form which is part of the approved IRB agreement that I sent to you before this interview? As this interview is voluntary, I must inform you that you can skip any questions or conclude this interview at any time. The interview will be approximately 90 minutes long. I'll ask you a series of questions in which there are no right or wrong answers. I would like you to feel comfortable with saying what you really think and how you really feel. The purpose of this study is to gain insight into the considerations of college admission leaders in reference to students pursuing STEM. This information would be used, without identifying information, to help inform practice and recommendations around equitable admission processes to STEM competitive majors. **Tape Recording Instructions:** With your consent, I would like to record our conversation. This will allow me to be accurate in capturing our conversation while also being an active participant in it and attentive to you. Your comments will remain confidential as I will compile a report which will contain comments from all of my interviews without attribution to participants. For example,
Set-up & Rapport	Before we get started, do you have any questions?
	<u>Topic 1: Leadership Journey</u> 1. Please share your pathway to becoming a chief admission officer. What are some highlights of your career journey that have led you to be an admission/enrollment leader? a. Probe: How have individuals and associations been influential in your ascension to the position of chief admission officer? **<u>Topic 2: Institutional Undergraduate Admission Context</u>** 2. In undergraduate admission, how do you serve your institution's commitment as a public-flagship institution?

3. How does your admission process uphold values of diversity and equity in its considerations?

4. Given the heightened level of scrutiny following the SCOTUS case (SFFA vs Harvard & UNC Chapel Hill), what becomes essential in establishing equity-based admission processes to competitive majors?

5. In your role, what institutional challenges is your admissions unit tasked to solve?

6. Can you please describe the involvement of faculty in your admission operations?
    a. Probe: Do they read files? Set policy? Participate in committee?

7. Are there specific considerations for your most competitive undergraduate majors at your institution?
    a. Probe: Focusing in on STEM, Are there stated admission requirements that are different for your STEM majors than other undergraduate programs? Particularly Engineering & Computer Science disciplines.

Topic 3: STEM Admission

8. How would you describe the challenges of admitting URM applicants to your STEM majors?
    a. Probe: From your perspective, are there areas, schools or regions in your state that are harder to find qualified STEM applicants?
        i. Probe: Can you characterize the demographic and socio-economic makeup of these applicants?

9. In what ways does your evaluation system mitigate the differences in STEM coursework availability in K-12?
    a. Probe: In what ways do you mitigate academic opportunity gaps in your applicant pool for equitable evaluation?

10. What challenges do you find in diversifying your STEM majors to include more URM students? Either with your faculty or with your applicant pool?

	a. Probe: How does the URM representation in your STEM majors compare to other selective majors at your institution? b. Probe: Are there other factors or influences that influence your approach? 11. As a leader, how do you engage your staff to value equity and diversity in their work? a. Probe: What challenges do you encounter training others to evaluate applicants equitably? 12. Before I hit stop recording, anything else you want to share?

Appendix B: Interview Protocol

Appendix C: Inquiry Map of Research and Interview Questions

Research Questions	Interview Questions
Introduction	1. Please share your pathway to becoming a chief admission officer. What are some highlights of your career journey that have led you to be an admission/enrollment leader? a. Probe: How have individuals and associations been influential in your ascension to the position of chief admission officer?
RQ1: How do chief admission officers in R1 public flagship universities characterize and analyze the challenges and inequities that URM STEM applicants face in the admission process?	2. Are there specific considerations for your most competitive undergraduate majors at your institution? a. Probe: Focusing in on STEM, Are there stated admission requirements that are different for your STEM majors than other undergraduate programs? Particularly Engineering & Computer Science disciplines. 3. In undergraduate admission, how do you serve your institution's commitment as a public-flagship institution? 4. In your role, what institutional challenges is your admissions unit tasked to solve? 5. How would you describe the challenges of admitting URM applicants to your STEM majors? a. Probe: From your perspective, are there areas, schools or regions in your state that are harder to find qualified STEM applicants? i. Probe: Can you characterize the demographic and socio-economic makeup of these applicants? 6. Can you please describe the involvement of faculty in your admission operations? a. Probe: Do they read files? Set policy? Participate in committee?
RQ2: Are there ways that chief admission officers of R1 public flagship universities create	7. How does your admission process uphold values of diversity and equity in its considerations? 8. Given the heightened level of scrutiny following the SCOTUS case (SFFA vs Harvard & UNC Chapel Hill),

opportunity and access to STEM majors for URM students?	what becomes essential in establishing equity-based admission processes to competitive majors? 9. In what ways does your evaluation system mitigate the differences in STEM availability in K-12? a. Probe: In what ways do you mitigate academic opportunity gaps in your applicant pool for equitable evaluation? 10. What challenges do you find in diversifying your STEM majors to include more URM students? Either with your faculty or with your applicant pool? a. Probe: How does the URM representation in your STEM majors compare to other selective majors at your institution? b. Probe: Are there other factors or influences that influence your approach? 11. As a leader, how do you engage your staff to value equity and diversity in their work? a. Probe: What challenges do you encounter training others to evaluate applicants equitably?
Conclusion	12. Before I hit stop recording, anything else you want to share?