Increasing STEM degree attainment for underrepresented populations

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Abstract

This qualitative study implements Critical Race Theory and the use of narrative to investigate reasons why rates of degree attainment in science, technology, engineering, and mathematics (STEM) remain particularly low among underrepresented minority (URM) students. Four African Americans who were formerly STEM majors at predominantly White institutions (PWIs) were interviewed to ascertain reasons why they changed majors or left higher education without reaching attainment in a STEM discipline. The explicit purpose of this research grounded study sought to discern how URMs could be better served within higher education classrooms and campuses to ensure greater numbers successfully enter the STEM workforce with a meaningful credential. A secondary purpose of the study sought to examine the cultural experiences of URM students initially enrolled in STEM degree programs who also identify with the culture of Hip Hop to examine the perceived usefulness of including elements from Hip Hop culture into the culture of STEM or the campus culture as a whole.

The implications of this study suggest various supports often implemented for URMs at PWIs are not effective enough to help increase attainment results to acceptable levels among URMs who often view the culture of STEM as particularly unwelcoming and insensitive to issues of race. A lack of a positive mentor and support within STEM was cited by those who left STEM majors for other disciplines perceived as more accepting and nurturing. All of the participants were familiar with Hip Hop culture and expressed favorable attitudes concerning incorporating elements of Hip Hop programmatically into STEM departments where it is noticeably absent.
Key Words: science, technology, engineering, and technology (STEM), underrepresented minority (URM), predominantly White institution (PWI), Hip Hop, critical race theory, narrative

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Acknowledgements

Those not familiar with the true essence of Hip Hop may find it shocking to realize that it is an embracive and welcoming culture, which often empowers its resident members to achieve confidence and find one's own unique voice. Through the principal elements of Hip Hop, and especially through rap lyric writing and poetry, I have come to experience a similar reality over the better part of my life—Hip Hop is a paradigm. It is for this reason that I am incredibly grateful to all of the pioneers of Hip Hop culture whom have helped make it a transcendent global phenomenon capable of enacting social change and enriching the lives of millions—including this artist-scholar-practitioner.

Pursuing a doctorate is a team sport, but only one individual walks away with the title. To help rectify this, I would like to acknowledge the many supporting roles which have made this accomplishment possible.

I am extremely thankful for the care and attention I have received from my professors at Northeastern University. I am particularly thankful for the guidance and mentorship I received from Dr. Joseph McNabb, the concentration lead for Higher Education, with whom I had the pleasure of having as my professor for two highly engaging courses. I often talk to others about my fantastic experiences here at Northeastern as a graduate student, including meeting many wonderfully supportive students within several of the doctoral cohorts working towards the same goal as me.

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My doctoral journey did not start in 2012, it has been a continuum since my first day of preschool—for that I am eternally indebted to my parents for their love, support, and encouragement to continue my education. Likewise, I would like to thank my extended family, including those who have passed away, for helping me achieve my goals. I would also like to thank my friends and all of the caring faculty I have been fortunate enough to have had motivate and support me throughout my lifelong education. I am also appreciative for all of the students I have been blessed to have taught and learned from; I am particularly indebted to the four participants in my study for trusting me enough to help tell their fascinating stories as well.

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Together, Henry and Nicole have become the greatest motivation I have ever had compel me towards completing any task. Failure was never an option. The subject of my dissertation is "Increasing STEM degree attainment for underrepresented populations." Nicole entered college as a freshman looking to earn a STEM based degree, and instead switched majors earning a degree in music. As a Black woman, she is severely underrepresented in STEM. While working on this degree, I often thought about her journey and amazing accomplishments, which have resulted in her ascending to leadership roles within the biotechnology industry. As proud as she is of me, I am equally proud and impressed by her grace, strength and poise—as a professional, a wife, and a truly incredible mother. Our love, hopes, and aspirations are personified through our most precious gift from God—our son, Henry James Jones Plourde. I can only hope that he will understand someday that this accomplishment seemed beyond me before he was born, but thanks to him, I have realized that anything is possible. If Daddy can do it, you can certainly do anything you choose as well!

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Chapter I: Introduction

Nothing is more consistent with attempting to live out the American Dream than seeking to achieve academic success punctuated by a college degree. Since the last official recession in 2008, however, employment rates have remained relatively sluggish for graduates looking for work; one notable exception is that science, technology, engineering, and mathematics (STEM) graduates are highly demanded as jobs in the science and high-technology sector continue to grow (Hagedorn & Purnamasari, 2012). Consistently absent in these sectors of the labor force, however, are people of color and women (Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010). Over the next several years, underrepresented groups will likely comprise the fastest growing segments of the population looking for gainful employment (Melguizo & Wolniak, 2012; Palmer, Davis, Moore, & Hilton, 2010). The US Census Bureau (2008) forecasted that by 2050 "minority" groups will technically no longer be in the minority, as they will comprise 50% of the population, as White percentages will continue to drop consistently each year as the middle of the century approaches.

Congress mandated in 1980 that the National Science Foundation (NSF) seek to improve underrepresented minority (URM) student's chances at STEM degree attainment due to a host of circumstances working against them (Lansquiot, Blake, Liou-Mark, & Dreyfus, 2011). Several years later, a study conducted by Elliot, Strenta, Matier, and Scott (1995) as a report to the NSF concluded only 34% of Black students initially declaring a STEM major went on to complete a STEM based degree compared to 61% of Whites. More recently, The US President's Council of Advisors on Science and Technology (PCAST, 2012) predicted that approximately 1,000,000 more STEM graduates are required over the next decade to keep pace with US workplace demands. Much of this shortage results from the low percentage (40%) of incoming college

freshman seeking to earn a STEM degree, with a retention rate among this group of only 40% as well (PCAST, 2012).

Statistics published by the U.S. Department of Education (Chen, 2013), based on a six year longitudinal study of over 13,000 students from 2003-2009, revealed that over 65% of Black students initially enrolled in postsecondary education STEM bachelor degree programs failed to reach STEM degree attainment (by either switching to non-STEM majors or leaving college altogether). Moreover, Black students initially enrolled in STEM bachelor degree programs also failed to earn a degree of any kind (by leaving college altogether) at a rate of over 29%, while their White counterparts failed only at a rate of 19%, with Hispanics doing so at a rate of just over 23% (Chen, 2013). The realities facing URM students are even worse for those initially enrolled in associate STEM degree programs; 77.8% of Blacks and 77.5% of Hispanics failed to earn the two year degree, compared to 66.1% of Whites (Chen, 2013). Though attrition rates among STEM degree seekers are alarmingly high, they continue to remain the highest among URM students (Chen, 2013; Melguizo & Wolniak, 2012; Rask, 2010).

After thirty-five years, it is clear that attrition in the first year of college remains a major obstacle for STEM degree attainment by URMs who also are commonly first generation students (FGS) with lower cultural capital (Bourdieu, 1986) than their traditional peers (Majer, 2009). Though it is now common to find predominantly White institutions (PWIs) claiming to have numerous "support structures" in place to help struggling students succeed, these practices are clearly not effective enough to help URM students graduate with STEM degrees at similar rates as their White counterparts at these traditional institutions (Glasson & Green, 2009). To counter this, it is critical that in the first year of college URM students (wherever they are enrolled)

connect with caring faculty, peers, or other aspects of the college campus and culture if they are to feel a sense of belonging and ultimately persist (Kendricks, 2011; Tinto, 2004).

Social disconnect for URMs, which can lead to isolation and eventual attrition, has been an emphasis of President Obama's 2010 campaign to improve STEM education (Johnson, 2011). Studies to find best practices which aim to improve rates of STEM degree attainment by diverse students often point to the issue of diversity and race being the basis for many students' feeling of isolation when they are among the very few on campus majoring in such disciplines (Hurtado, Newman, Minh, Tran, & Chang, 2010). This problem is true for URMs regardless of major but is exacerbated for those majoring within STEM disciplines; URMs often disclose the presence of unwelcoming class atmospheres created by STEM faculty members as a common reason for their attrition (PCAST, 2012; Rask, 2010). Yet, research has revealed an increased likeliness of students of color to persist in college when peer groups are established through first year programs (Hurtado et al., 2010). This first year, however, often starts before the traditional fall semester in which most students begin their academic careers. By utilizing precollege experiences through summer programs prior to their freshman year in college, vast amounts of URMs have been successfully "pipelined" into the culture of the campus via STEM summer-camps which allow students the opportunity to perform research with faculty and counselors from diverse backgrounds (Johnson, 2011; Slovacek, Peterfreund, Kuehn, Whittinghill, Tucker, Rath, & Reinke, 2011; Stolle-McAllister, Sto. Domingo, & Carrillo, 2011; Subotnik, Tai, Rickoff, & Almarode, 2011).

Today there is perhaps no greater example of the positive effect belonging has than at historically Black colleges and universities (HBCUs) which consistently turn out better numbers of URMs than their predominantly White institution (PWI) counterparts (Museus & Liverman,

2010). Community colleges typically enroll a far more diverse student body and the ensuing

transition to an HBCU, which enrolls large numbers of African Americans, allows many students

to have a seamless experience (Jackson, 2013). STEM cultural capital (including STEM career

options) is more readily developed in comforting social groups at community colleges among

individuals who have similar interests and backgrounds (Jackson, 2013). However, even at

PWIs, educators who are able to tap into the culture of URM students more effectively may be

able to play a significant role in helping to alleviate the problem of attrition, which

disproportionately affects URM students and women in STEM (Johnson, 2007).

  The educational community has taken note of how student identities are often

renegotiated when Hip Hop culture becomes infused within the official curriculum or

pedagogical approaches of the instructors (Hill, 2009). The embracing culture of the global

phenomena of Hip Hop is often a salient commonality shared among URM students and,

therefore, is a well-known powerful tool in the classroom (and beyond) when used respectfully

by informed educators (Bridges, 2011; Emdin, 2010; Emdin, 2011; Hall & Martin, 2013; Hill

2009; Stovall, 2006). In Petchauer's (2010) ethnographic study, he explains we should not

conceive of Hip Hop as an isolated element in students' lives, which they simply engage in

during downtime, rather it ought to be correctly viewed as intrinsic to how they interact with

family and how it shapes their core values concerning education and overall beliefs. Hip Hop has

reshaped the landscape of pop culture for about 40 years and has more recently emerged as a

framework for understanding youth pop-culture ever since the late seventies (Brown, 2010).

  Lyrical (2013) explains how the tenets of the culture emerged via its' principal founder,

Afrika Bambaataa, and how those tenets are often widely misunderstood and under-taught in

grade school and at the university level. Bambaataa, a former gang member, declared, taught,

and reinforced the pillars of Hip Hop as peace, unity, love, and having fun and utilized the culture as a way to end gang violence (Lyrical, 2013). Bambaataa's tenets have parallels to what Rodriguez (2009) says were the foundations of Freire's work, namely that Freire believed in establishing educational conditions which allow the oppressed to liberate themselves driven by the pedagogical principles of "love, hope, and justice" (p. 22). After a trip to Africa, Bam returned to his home in the South Bronx as a converted missionary who realized that the power of this emerging cultural movement would be the tool necessary to help stem violence in the streets (Lyrical, 2013). Bambaataa has since gone on to be employed as a visiting scholar at Cornell. There he teaches the true history of Hip Hop as a conduit for positive change among young urban youth relegated to impoverished areas, while destroying the pervasive myth often circulated within the mainstream media that Hip Hop has historically been a cause of street violence (Lyrical, 2013).

Within the lyrics of rap music, it is common to find a multitude of supportive messages which reinforce positive self-imagery, lift self-esteem, and nourish the soul (Travis, 2012). Students who traditionally have been marginalized and disconnected from the culture of STEM often have vast cultural and social capital (Bourdieu, 1986) within the culture of Hip Hop, however this culture is largely misunderstood by many STEM educators (Emdin, 2010). Further, the culture of science found within the STEM classroom provides a nearly polar opposite cultural environment than the one many URM students, especially those from urban areas, have experienced as products of Hip Hop culture (Emdin, 2011). Unyielding and unforgiving chilly laboratory climates are often described to exist inside of STEM classrooms (Emdin, 2010; Museus & Liverman, 2010; Seymor & Hewitt, 1997). These conditions run counter-culture to the essence of the historically embracive culture of Hip Hop (Emdin 2010; Lyrical, 2013).

Travis (2010) explains that Hip Hop culture and its principal element of rap music were birthed out a unique urban landscape of oppression. This provided impetus which fueled the culture of Hip Hop with ingenuity and innovation and still informs the music of the culture today—while also serving as a principal voice against oppression and inequality. If one wishes to engage URM students on traditional campuses there is perhaps no greater potential vehicle available to educators than attempting to better understand the culture of Hip Hop and including it via curricula and pedagogically within their lessons (Emdin, 2010; Emdin, 2011; Hill, 2009; Hill & Petchauer, 2013; Petchauer, 2010).

Problem of Practice

Predicted labor shortages in many highly skilled professions across the nation make it imperative that we increase the numbers of traditionally underrepresented citizens who graduate with science, technology, engineering, and mathematics based degrees if we are to keep pace with nations that are churning out far higher rates of graduates in these areas (Melguizo & Wolniak, 2012; Palmer et al., 2010; Perna et al., 2010). However, high attrition rates, especially among minority STEM majors, makes this national problem an even more pressing concern for stakeholders to deal with. Further, individuals from underrepresented groups historically have been marginalized out of the cultural equation of STEM, yet often possess vast social and cultural capital in the area of Hip Hop culture which STEM instructors often fail to tap into as a pedagogical tool in the classroom (Emdin, 2010; Emdin, 2011). If only certain institutions perceive this as a national problem, we will continue to alienate and underrepresent URM students whom overwhelmingly identify with the culture of Hip Hop, yet find it almost entirely absent from the culture of STEM promulgated through the majority of institutions producing our future scientists.

Significance of the Problem

Low rates of enrollment and degree attainment among underrepresented populations such as lower income, first generation, and minority students is one of education's most compelling dilemmas (Hurtado et al., 2010). The United States simply cannot afford to continuously leave behind underrepresented minorities out of the STEM equation if it wishes to maintain and significantly improve its competitiveness in an increasingly high-tech global economy (Palmer et al., 2010). Higher education leaders must deal with the nation's difficulty in recruiting and retaining a diverse student population—specifically those seeking to attain a STEM based college degree or credential. Hip Hop culture, birthed as a byproduct of the Civil Rights Movement, has shaped the perspective of an entirely new generation—the Hip Hop Generation (Kitwana, 2002), which has also witnessed a serious decay of the various social and educational gains its forerunners worked tirelessly to secure (Bridges, 2011). An increase in Hip Hop centric pedagogy and curricula within STEM departments would serve as a welcomed and natural fit for many institutions looking to help attract and retain more diverse students (and educators), while helping to create a more welcoming climate for true campus diversity more consistent with the national population (Bridges, 2011; Emdin, 2010; Hill 2009; Petchauer, 2010). The added benefit that diversity brings to higher education and the workplace, along with the national shortage of talented STEM trained employees ready to meet demands in increasingly technical workplaces, now motivates colleges, corporations, and other organizations to recruit, enroll and retain minority students.

Positionality Statement

It is crucial that the researcher discuss personal and political ideologies to inform the end users how this impacts and shapes the final version of the study (Creswell, 2013). Further, the

researcher's preexisting views and theories regarding a given phenomenon require that a process of detachment of bias occurs during a critical reflection phase (Machi & McEvoy, 2009). Likewise, the researcher acknowledges experiences as a mathematics lecturer for a decade at various higher education institutions in the Greater Boston area, as well as a math instructor in an urban high school for several years, which have given rise to the positionality that racism and cultural bias have played no small parts in contributing to a less than ideal climate within STEM disciplines for URMs. Being one of the very few Spanish speakers in a heavily Latino populated school district in Lowell, Massachusetts, the researcher was often made aware of several of the ongoing inadequacies and injustices (via providing translating services for parents) which Latino families regularly were forced to endure within the school district. Additionally, the researcher is married to an African American woman and is the father of a multi-racial child. This and a multitude of other factors have contributed to the researcher's implementation of the theoretical framework of Critical Race Theory (CRT).

As a theoretical framework, CRT is well aligned with the researcher's held assumption that one's culture, ethnicity, and race likely play large factors in higher educational institutions which historically foster cultural climates not conducive to URMs (Museus & Liverman, 2010; Slovacek et al., 2011; Palmer et al., 2010; Taylor, Gillborn, & Ladson-Billings, 2009). Critical theorists, such as Villalpando (2004), explain the most effective way to extract the experiential knowledge which marginalized (Latino) students often possess is achieved via simple inquiry regarding their experiences before and during (and after) college. The results often reveal vast experiential histories have been passed down to them via storytelling, family histories, and other narrative methods have often been utilized as the prime method for knowledge transmission (Delgado, 1989; Ladson-Billings, 1999). Ladson-Billings (1999) argues that narrative is

paramount in knowing and understanding our social world, and suggests that a major feature of CRT is that a given person's narrative and story is fundamental to CRT. This aspect of the chosen methodology highlights the benefit of utilizing narrative study in conjunction with CRT. With this in mind, it is important to acknowledge the opportunity (and role) which narrative inquiry affords the researcher: that of questioning original viewpoints, as well as the inherent position of privilege (Martin, 2014). Therefore, combining the lens of CRT with the methodology of narrative inquiry seems to be especially valid for this particular qualitative study.

However, it is clear that racism and cultural bias may not *always* be a prime factor resulting in URM attrition in STEM; the degree to which it has been a factor for those participating in the study has helped inform the results. This researcher, a mathematics instructor, has abandoned his own preference for quantitative methods in favor of the more appropriate tradition of qualitative methods to better describe and make sense of the natural phenomena embedded in this study's problem of practice (Creswell, 2013).

Moving more of our young people towards college completion should be a pressing national concern despite any political agenda or societal belief. Before becoming a full time mathematics instructor at Northeastern University, Sports in Society (a program at Northeastern) hired this researcher as a guest speaker for an event in May 2008. Hundreds of Boston middle-school students were informed about how the passion for Hip Hop and education had helped to transform several lives, including the life of this researcher (Lyrical, 2013). The students were told to push forward with their desire to learn and always to ask questions about their curiosities; this resulted in many questions about how to manage dual careers and interests. They were next informed that being a rapper, mathematician, student, and adjunct member of several faculties

had been manageable because of this researcher's passion for the work. It was explained that small successes in life had manifested for the researcher by simply pursuing careers [rapping and teaching math] that were personally invigorating—and not necessarily due to an original strength in these areas as a child (Lyrical, 2013).

Due to the upbringing of this researcher, and the living experiences formed within multicultural communities and families, this research will incorporate an awareness of the many injustices that take place in predominantly low-income, urban areas with high rates of minority citizens (Lyrical, 2013). Additionally, as an active participant within the culture of Hip Hop since childhood, the researcher has been immersed in an inclusive multicultural environment which fosters an even greater appreciation for issues pertinent to many members representative of our most often exploited, and vulnerable underrepresented populations.

The researchers' work as a collegiate instructor was grounded first in gratifying employment as a high school teacher within his native city of Lowell, Massachusetts. This researcher entered the field of education by interviewing for a position as a math teacher at Lowell High School. After being hired by the school, this researcher shortly after began teaching students in the high school's alternative program (this alternative model was largely based on students who had academic and behavioral issues), which predominantly consisted of low-income minority students.

This researcher is now a math instructor in the Foundation Year Program at Northeastern University, teaching primarily African American and Latino student populations, very similar in racial, ethnic, and socio-economic backgrounds as the students from Lowell. This researcher has also made his public identity of a Hip Hop personality and rap performer (PKA "Professor Lyrical") known to all participants since the content of the material in the researcher's music and

lyrics advocates for more cultural inclusion in the schools and an increased presence of minority students in academia and in the STEM workplace (Berrett, 2011; Lyrical, 2013). The value of such disclosure cannot be understated in narrative research (Creswell, 2013). For these reasons, this researcher has been motivated to uncover explanations that serve to effectively alienate URM students as outsiders often devoid of the cultural capital and self-efficacy crucially required for success on college campuses (Emdin, 2011; Fife, Bond, & Byars-Winston, 2011; Harper, 2010; Majer, 2009). Obstacles such as a lack of appreciation by faculty for the culture many URMs bring to the classroom are investigated in the review through a critical lens.

By also examining several successful colleges that churn out URM graduates in STEM disciplines, this literature review provides strategies which are already working on some campuses (such as HBCUs), which may or may not be transferable to other institutions. These include practices such as providing positive faculty/staff role models on campuses, peer-mentoring development, racially sensitive and inclusive academic and socially diverse environments, proactive first year programs and numerous other devices that attempt to remove traditional URM roadblocks. This research project also examines whether claims of improvement are substantiated with causal relationships while looking to determine validity of reports free of researcher bias.

It is important for all those utilizing this research to know how the researcher's life experiences may have colored the lens through which the study is viewed. A given researcher's theory is nothing more than a philosophical assumption that establishes a framework for how one sees the world. This bias is extremely important to consider whenever one is proposing a theory to help explain what is at work impacting a given population being studied (Machi & McEvoy,

2009). Though this theoretical framework is important to acknowledge, it has not forced the results of the study based on previous notions or assumptions.

Purpose Statement

No serious attempt to remedy the nation's lack of home-grown STEM qualified workers can take place without more research addressing the shortfall of URMs who go on to earn a STEM credential from a higher education institution. HBCUs should not be expected to shoulder this burden alone; however, there is much to be learned from their comparative success educating and preparing this population for the workplace. Therefore, the purpose of this study is to help increase degree attainment among URM students majoring in STEM disciplines at predominantly White institutions, principally by understanding the key factors which led to attrition out of these majors. As an additional purpose of this study, this researcher seeks to examine the cultural experiences of URM students initially enrolled in STEM degree programs, and already identifying with the culture of Hip Hop, to help ascertain the perceived usefulness of including elements from Hip Hop culture into STEM department curricula, pedagogical delivery systems, or the campus culture as a whole.

On a practical level, this study has been conducted with the explicit purpose of attempting to discern how URM students might be better served within higher education to ensure greater numbers successfully enter the STEM workforce with a meaningful credential. To bring about better results, however, especially for individuals from marginalized populations, educators and institutions historically have concentrated on changing the student's behavior and have entirely neglected the need to change the classroom or campus system (Seiler & Elmesky, 2007). Evaluating URM students' perceptions of the culture of STEM and comparing this to their own cultural identities may yield helpful results for educators, administrators, and policy

makers. This study directly considers the lived experiences of four individuals from historically marginalized populations to better understand how higher education institutions might more effectively reach, retain, and ultimately graduate URM students majoring in STEM.

Research Questions

The central research question for this study is: Which factors do URM students who have left STEM degree programs feel played the most significant roles leading to their own attrition? The supporting question for this study is: How do URM students feel STEM education in higher education institutions could be conducted more effectively to reach and retain URM students? An additional question emanating from answers to this supporting question is: What role could the infusion of elements from Hip Hop culture into various aspects of higher education play in potentially alleviating the issue of attrition for URMs majoring in STEM disciplines?

Theoretical Framework

The theoretical framework guiding this study is grounded in Critical Race Theory (CRT), specifically as it applies to education (Ladson-Billings, 1998; Ladson-Billings & Tate, 1995; Tate, 1997). CRT has come to fruition resultant of a vast body of work produced by legal scholars and other academics and educators who collectively maintain that racism is indeed a common feature of society. CRT provides scholars and other advocates a strong framework helpful for improving understanding of how racial inequality is often maintained by legal and social norms (Crenshaw, Gotanda, Peller, & Thomas, 1995).

Harvard University Professors, Derrick Bell (African American) and Allan Freeman (White) established the foundations of CRT during the second half of the 1970s as an outgrowth of their own mutual frustrations with the slowing momentum of civil rights activism and racial reform. CRT has historically offered a sharp critique to liberalism (and of course to conservative

legal policies), primarily due to the painstakingly slow pace in which liberalistic policies and mechanisms work to advocate for civil rights for people of color (Ladson-Billings, 1998). Delgado and Stefancic (2001) posit CRT has developed into a *movement*, consisting of activists and scholars similarly interested in, not only studying—but, transforming the various relationships at work between racism, race, and power.

William Tate (1997), though initially reluctant to reduce the elements of CRT down to discrete descriptions, does proceed to define five key ideas central to CRT as follows: 1) recognizes racism as endemic throughout US society, 2) crosses epistemological boundaries borrowing from the legacies of the various movements it encompasses, 3) awareness of the limitations within civil rights law and multiculturalism within the educational arena, 4) self-interest of the most powerful in society is the driving force behind legal claims for meritocracies, colorblindness, and race-neutral agendas, 5) insistence on inclusion of people of color's experiential knowledge in interpreting law and society while examining established laws contextually (p. 235). When utilized as a lens in education, CRT examines how "color blind" institutional policies and practices continually perpetuate inequality along ethnic and racial lines while exacerbating White privilege (Ladson-Billings & Tate, 1995; Solórzano, 1997; Villalpando, 2004; Yosso, 2005). Further, this lens provided by CRT may be "given back" to the oppressor (or dysconcious-educator) as a means for communicating the harsh realities experienced by the oppressed, in what Ladson-Billings and Tate (1995) calls "a first step on the road to justice" (p. 58).

In Ladson-Billings seminal work (1998) on CRT and its place in education, she explains how capturing the voice of members of those marginalized by race has been a historical goal of CRT in an attempt to alleviate the social burdens imposed by racial hegemony. Ladson-Billings

(1998) expands on the work of key pioneering CRT theorists and researchers (Bell, 1987; Crenshaw et al., 1995; Delgado, 1990; Tate, 1997) by demonstrating how extracting the lived voice of people of color is necessary to highlight the deeply pervasive nature of racial marginalization across a wide away of social structures—including educational institutions. CRT has evolved into a tool which challenges the growing momentum of "colorblind" merit based systems in higher education and demonstrates the lopsided distribution of resources, power, and privilege permeating across a vast array of social institutions—which often exacerbate deeply pervasive disparities faced by racial minorities (Delgado & Stefancic, 2001; Dixson & Rousseau; 2006; Taylor et al., 2009).

Scholars such as Yosso (2005) have defined CRT in education "as a theoretical and analytical framework that challenges the ways race and racism impact educational structures, practices, and discourses" (p. 74). In restating Solórzano's (1997) contribution to CRT as it pertains to education, Yosso (2005) identifies five basic tenets, as well, which serve to inform and guide the research of educators as they look to develop more meaningful and liberating pedagogy and curriculum: "(1) the intercentricity of race and racism; (2) the challenge to dominant ideology; (3) the commitment to social justice; (4) the centrality of experiential knowledge; and (5) the utilization of interdisciplinary approaches" (p. 73). While these five central ideas have overlap consistent with Tate (1997), here CRT emphasizes the potential role schools are well-positioned to play in the quest for liberation and social justice—which hooks (1994) and Freire (1970) have both previously called for. Inherently, this is recognition of the contradictory reality of educational institutions as conduits of oppression and marginalization, even though they possess great potential to empower and emancipate (Yosso, 2005).

According to Hiraldo (2010), the role of CRT in Higher Education similarly boils down to five similar tenets as well: "counter-storytelling; the permanence of racism; Whiteness as property; interest conversion; and the critique of liberalism" (p. 54). Hiraldo (2010) argues these various tenets of CRT can play a substantial role if, and when, higher education institutions truly commit towards more diversity and inclusion via the systematic removal of various deeply ingrained societal disparities which thrive on college and university campuses. Hiraldo (2010) contends if institutional change is a priority, simply attempting to implement policies at PWIs which increase the quantity of enrolled students of color is not enough, rather increasing campus initiatives to place culturally competent and diverse faculty, staff, and administrators in key positions is a far more effective way of increasing campus diversity and inclusion.

Definition of Key Terms

Several key terms are used extensively throughout this document and are defined for clarity in this section of the document.

Attainment. The formal process of earning a degree from a higher educational institution.

Attrition. When students do not persist towards their goal of attainment and eventually leave an institution of higher education without a degree. This is more commonly known as "dropping out" of school, but for purposes of this paper it also refers to people who switch out of STEM majors while continuing on with their studies. Attrition was first examined in higher education by Tinto (1975) using his Student Integration Model. He saw dropping out as a connected process over the long term, shaped by various interactions between the student and the academic and social features of the institution, which ultimately would lead to attrition if students felt a sense of disconnect, lack of involvement, or non-belonging.

Higher Education. The formal schooling after a secondary education which takes place in colleges, universities, or institutes of technology (this also includes online educations at these institutions as well). Degrees offered by increasing level of achievement include Associates, Bachelors, Masters, and Doctorates. Universities typically are distinguished by both the granting of undergraduate and graduate degrees (including the doctorate), as well as a prevalence of students and faculty often involved in academic research. Though many colleges also offer certain graduate level degrees and engage in research as well, they are typically more centered upon granting undergraduate educations, often with less focus than universities require upon producing academic research. Community colleges primarily grant the two-year associates degree required by many employers and/or serving as evidence for other colleges and universities of adequate preparation for attainment of the bachelor degree. Community colleges are well known for providing a great deal of in-demand workforce skills and training (Malcom, 2010).

Hip Hop. DJing, MCing, B-Boying/B-Girling and Graff writing are known as the main four elements of the culture of Hip Hop. Hip Hop Legend, KRS-1, founded "The Temple of Hip Hop" which lists and explains the original four elements (Breaking, Emceein, Graffiti Art, and Deejayin), along with five others. The more complete nine elements of Hip Hop include: "Breakin, Emceein, Graffiti Art, Deejayin, Beat Boxin, Street Fashion, Street Language, Street Knowledge, and Street Entrepreneurialism. "Hip-hop" or "hip-hop" with a lower case first "h" is a variation of the definition and spelling listed with the Temple of Hip Hop. It denotes the musical product(s) of the genre, namely rap. Many tend to capitalize it unless strictly representing the word as a genre" (Lyrical, 2013). Hip Hop expert, author, and Northeastern Professor Murray Forman (2013) explains however, "Hip-hop certainly can't mean the same

thing to everyone under all conditions and the critical question has always been, within what contexts are its meanings established and how are they negotiated among disparate or antagonistic forces" (p. 244)? Throughout this paper the term Hip Hop will continuously refer to the positive culture, including these core elements which originated in the South Bronx of New York City in the early to middle 1970s, and how it has historically served to help curb gang violence since shortly after its inception. It should be noted that "rap" music or "rapping" is commonly confused with the larger culture of Hip Hop; it is simply one very popular element of the culture which also contains many subgenres as well.

STEM. The acronym for science, technology, engineering, and mathematics, normally referring to disciplines of study, or areas of industry, containing these broad categories of knowledge. Though no one true definition of what counts as a STEM major exists, the NSF and the Department of Homeland Security have produced expanded lists of what they consider STEM. However, since there is no one defining authority, it is left up to specific higher education institutions themselves to define what they consider as a STEM major. STEM jobs consistently pay more on average than jobs requiring a similar degree in other subject areas and project to consistently outperform levels of employment in other fields requiring a similar level of formal education (Vilorio, 2014). STEAM is also a common acronym when incorporating the arts (as the "A"), and would be appropriately used when denoting instances wherever Hip Hop culture is intertwined with STEM as well.

URM. The acronym for underrepresented minority, commonly utilized in a vast array of academic studies. Far from a perfect term, it may have different meanings across different papers and studies, here particular focus is paid to members from groups who are traditionally underrepresented at higher education institutions (especially in STEM) and likewise become

underrepresented in the workforce. The groups which are considered URMs in the United States within STEM fields include Black, Latinos, Native Americans, and Pacific Islanders. Asians, though clearly a minority in the United States, are used along with Whites as a reference group due to their high representation in STEM fields (Chang, Sharkness, Hurtado, & Newman, 2014).

Summary

Science, Technology, Engineering, and Mathematics graduates are nationally in high demand as jobs in the science and technology sector continue to grow at a rate that currently requires employers to fill a large portion of these openings with highly qualified candidates abroad. Notoriously absent in these sectors of the national labor force, however, are people of color—with women of color severely under-represented in the field as well. The added benefit diversity brings to higher education and the workplace, in conjunction with the national shortage of talented STEM trained employees in increasingly technical workplaces should serve as strong motivation for colleges, corporations, and other organizations to recruit, enroll and retain more URM students into STEM pathways.

Research shows that various peer-assisted models where URMs work with other students as mentors and faculty with positive self-images and higher self-efficacy have produced excellent results at urban campuses with higher than average numbers of URMs (Lansiquot, Blake, Liou-Mark, & Dreyfuss, 2011; Majer, 2009; Myers & Pavel, 2011). HBCUs and institutions which have received funding to support URM students have had promising results producing more diverse STEM graduates. Additionally, recreating a similar atmosphere using the more generalized culture of Hip Hop, the predominant culture of urban youth, may be able to welcome in students of socio-economic status – regardless of race – and build upon the larger commonality of shared cultures of today's urban community (Emdin, 2010). It is important,

however, to directly consider the story of more URM students who have not been so fortunate to attend such progressive institutions. Therefore, more work needs to be conducted at PWIs to better understand how campuses and STEM departments can improve their chilly climates— which URMs often must tolerate and persist through, less they succumb to non-attainment.

Organization of this Document

The following chapters of this document include the literature review (Chapter 2), the research design (Chapter 3), the findings of the study (Chapter 4), and a summary with recommendations for how to proceed with what has been learned (Chapter 5). In the next chapter (Chapter 2), an explanation of the selected methodology tradition of a narrative research design is provided, which additionally details how this methodology is well aligned with the chosen theoretical framework (Ladson-Billings, 1998). This affords the opportunity to illustrate how educational institutions often reproduce social inequity as opposed to functioning as effective agents of change, which Hip Hop culture is often more well-suited to address when implemented by progressive educators (Bridges, 2011; Emdin, 2010; Emdin, 2011; Emdin & Lee, 2012; Hall & Martin, 2013; Hill, 2009; Hill & Petchauer, 2013; Stovall, 2006).

Chapter II: Literature Review

The lack of diversity in STEM has long concerned researchers and policy-makers who are cognizant that a lack of graduates in these fields poses a serious threat to US international competitiveness (Hurtado et al., 2010; Rask 2010). The increasing demand for highly qualified and technically trained workers, coupled with the ongoing shortage of URMs in the STEM pipeline presents considerable social and economic problems that must be addressed. If the United States wishes to maintain, and significantly improve, its competitiveness in an increasingly high-tech global economy, it no longer can afford to continuously leave URMs out of the STEM equation (Palmer et al., 2010).

Academic institutions and their leaders are integral players in potentially helping to alleviate the nation's difficulty in recruiting and retaining a more diverse student population—specifically those seeking to attain a STEM based college degree or credential. Higher education, therefore, must play its role. The attrition rates for those majoring in STEM disciplines are alarmingly high, but they are highest for URM students. Attrition in the first year of college is a significant obstacle for STEM degree attainment by URMs who also are commonly first generation students (FGS) with lower cultural capital than their traditional peers (Majer, 2009). URM students arrive at college with various levels of expectations, anxieties, achievement and ability level—based largely upon differences across high school coursework, social and cultural norms (and capital), levels of familial support, prevalence of mentors, and other social influences (Majer, 2009; Rask, 2010). These expectations and varying ability levels often clash with collegiate STEM departments, curricula, faculty, peers and culture, influencing a student's decision whether or not to take another STEM course. Unfortunately, these factors more often

than not may lead to change of majors outside of STEM, thus contributing to an increase in attrition among initial STEM degree seekers (Rask, 2010).

According to Columbia University's Christopher Emdin (2010), "Hip-hop, a culture with roots in alienation from an existing mould, offers a space of solace for students who are not allowed to participate fully in schools. In other words, when students feel alienated from school or from science, they often respond by deeply affiliating themselves with hip-hop culture" (p. 2). It follows that an increase in Hip Hop centric pedagogy and curricula within STEM departments potentially serves as a more welcoming fit between URM students and institutions looking to help attract and retain a more diverse student body (Bridges, 2011; Emdin, 2010; Hill 2009; Petchauer, 2010). Higher education simply must do more to embrace the dominant culture prevalent among URMs, which is seemingly at odds with the culture of STEM, if it looks to retain this valuable portion of its students enrolled in STEM majors. The national shortage of highly qualified STEM trained workforce, along with the added benefit that diversity brings to higher education and the workplace now motivates universities, colleges, corporations, and other organizations to recruit, enroll and retain minority students.

Organization of the Review

The literature review commences with a brief description of the theoretical framework of Critical Race Theory (CRT), first presented as a useful educational theory and framework by Ladson-Billings and Tate (1995), which will guide this study. Next, the merits of Cultural Capital Theory (Bourdieu) and how the theory is a beneficial paradigm for understanding inequity in education is discussed in conjunction with higher education (and CRT) and other more recent takes on social, cultural and linguistic capital. The review of the literature focuses on research concerning the high rates of attrition among URMs majoring in STEM. The review

concludes by documenting many of the principal tenets of Hip Hop culture and how they thematically are well aligned with many aspects of the theoretical framework.

Critical Race Theory

The theoretical framework guiding this study is grounded in Critical Race Theory (CRT), specifically as it applies to education (Ladson-Billings, 1998; Ladson-Billings & Tate, 1995; Tate, 1997). CRT emanates from a vast body of work undertaken by legal scholars and educators maintaining that racism is indeed a common feature of society. CRT provides scholars and other advocates a strong framework helpful for improving the understanding of how racial inequality is often maintained by legal and social norms (Crenshaw, Gotanda, Peller, & Thomas, 1995).

Cultural capital. The global phenomenon of Hip Hop is the overwhelmingly identified culture of today's urban youth (Emdin, 2010; Hill, 2009). Therefore, this researcher has sought to discern how higher educational institutions may capitalize on the shared experiences of URM students who have typically been marginalized out of the STEM equation and culture of science, yet often possess vast social and cultural capital in the area of Hip Hop culture (Emdin, 2010). For these reasons, this researcher utilizes the lens of cultural capital as explored through the seminal work of Pierre Bourdieu (1986).

Hiraldo's (2010) insights on the potential for higher education to utilize CRT as a lens to improve the institution via structural resources together with Yosso's (2005) perception of the power of CRT as a liberating tool for higher education instructors working with students in the classroom inform this study. The counter-stories Hiraldo (2010) calls for, in order to properly analyze higher education's climate, provide all people of color within a given institution a voice in which to establish authentic narratives pertaining to experiences of marginalization. Yosso (2005) similarly authenticates the "voice" of people of color by examining their various forms of

cultural capital as first put forth into theory by Pierre Bourdieu (1986). Yosso (2005) details how these capitals also include aspirational, navigational, social, linguistic, familial, and resistant capital as well. Yosso (2005) argues these forms of capital allow informed educators to draw upon the multiple knowledge bases students of color bring with them from their communities and homes.

Bourdieu's conceptualization of cultural capital finds particular relevance within an educational context, while also partially aligning with many of the principals of CRT, albeit more along lines of class than of race. Bourdieu sought to demystify vastly unequal levels of academic success across the social classes by suggesting that distribution of cultural capital between the classes was in itself an inequity (Bourdieu, 1986). It was Bourdieu's rendering of cultural capital, which situated it as a major conduit towards enhancing social inequality—and not as a liberating agent of progressive social change as many have fashioned it. Therefore, those students who reflect the values and experiences of the ruling class, and of those crafting policy, are those destined to become the winners in an academic, cultural and social sense.

From an educational approach, CRT requires schools to empower their students towards actualizing a number of these capitals while striving towards the larger purpose of racial and social justice (Yosso, 2005). This is a radical break from many of the deficit approaches in education which have traditionally assumed people of color lack important skills and more traditionally valued forms of capital, which Bourdieu (1986) first postulated would be the detriment of less advantaged students not from the dominant class (Harper, 2010).

In defining "linguistic capital," Yosso (2005) draws on years of research examining bilingual education and the awareness that students of color arrive with nuanced understandings and appreciation of oral traditions and histories—often with the ability to communicate through

poetry, music, and art. Yosso (2005) endnotes how her new found appreciation of "graffiti and hip hop poetry as unacknowledged sources of community cultural wealth [have] expanded my thinking about linguistic capital" (p. 83). This is further evidence, as Creswell (2013) argues, how CRT empowers scholars and practitioners to vividly illustrate the lived experiences of marginalized members of society, especially since it is often difficult for those in the majority population to relate to such experiences unless well-narrated and highly contextualized stories are provided to help convey the importance and unfairness of racial inequity. Following this line of thinking has established the basis for this study, with its narrative methodology helping to capture the experiences (and capital) of various URMs who have found it necessary to either withdraw from STEM majors—or from higher education entirely—before reaching attainment.

High Rates of URM Attrition out of STEM

For well over a decade, predicted national labor shortages in many highly skilled STEM professions have made it imperative the nation increases its numbers of traditionally underserved citizens who graduate with science, technology, engineering and mathematics based degrees (Hubbard & Stage, 2010). The United States continued to lose its competitive advantage in science and technology several years after the National Academies published its report about how this problem was a "gathering storm" that required immediate national attention and committed resources to solve (Landers, 2010).

While a recent increased national focus on STEM has resulted in substantial increases among students starting STEM degree programs at four-year colleges and universities, substantial amounts of students still leave their intended majors at alarming rates (Allen-Ramdial & Campell, 2014). This STEM attrition is exacerbated among undergraduate URM students and

compounds in severity for those URMs attempting to attain each successive level of graduate degree (Allen-Ramdial & Campell, 2014; Rask, 2010).

The literature reveals the fact that various research studies have identified key factors which serve to decrease attrition and thusly increase rates of STEM degree attainment for students attending traditional 4-year higher education institutions (see for example Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012; Tinto, 1993; Titus, 2004). Other related studies have been conducted with particular focus upon URMs majoring in STEM fields (Allen-Ramdial & Campell, 2014; Chang et al., 2014; Perna et al., 2010; Seymour & Hewitt, 1997). With this increased research, scholars and practitioners are becoming more aware of the effects of isolationism on campuses, and how the low-expectations and beliefs of faculty have strong negative impacts upon URMs which potentially lead to rapid attrition (Chang et al., 2014; Hubbard & Stage, 2010;).

High rates of attrition among URMs in the first year of college has been consistently linked to their poor experiences in STEM courses (Chang, Cerna, Han, Sàenz, 2008; Palmer et al., 2010). Though pre-college preparation was early on the prime suspected factor contributing to such attrition, slowly a growing body of research has emerged to proclaim that a lack of student engagement in STEM is likely a larger factor (Chang et al., 2014; Hurtado et al., 2010). Chang et al. (2014) argues that if the level of student high school STEM preparation was drastically increased it may not be enough to guarantee a marked improvement in STEM degree completion unless introductory college course engagement is significantly increased. This lack of engagement is thought to be a byproduct of attitudes and behaviors of professorate who teach the coursework, and less to do with the how resourceful and naturally motivated the students are when they initially come to class (Chang et al., 2014; Palmer et al., 2010).

Introductory courses at many highly selective institutions function as "gatekeeper" courses, which often do more to screen out—than to nurture—the incoming talent (Gasiewski et al., 2012). Deconstructing the hierarchy of knowledge dissemination where students sit passively by watching the leader lead the class through lecture has started to give way to the development of active learning pedagogies (National Research Council, 2003) seeking to engage the students while helping them incorporate their own lived experiences into their coursework (Gasiewski et al., 2012). Many introductory STEM instructors, however, have been historically very reluctant to incorporate these methods, and instead rely upon more traditional instructor led lecture (Gasiewski et al., 2012). Unfortunately, this often leaves out the diverse viewpoints, voices, and experiences of URM learners and keeps these courses from welcoming in all perspectives and issues traditionally faced by URMs. This serves to only further alienate those who are already marginalized by dictating through null curriculums the insignificant role of people of color or diverse ancestry in American history. Similarly, hidden curriculums (Apple, 1971) may tacitly establish that the *correct knowledge* is only found, and emanates, in one direction—from the front of the classroom. This forces students to listen non-critically while scurrying to *copy* every word of the lecturer—something already devalued by those steeped in Hip Hop culture (Hall & Martin, 2013).

Research conducted by Gasiewski et al. (2012) concludes that these sorts of hidden and null curricula impact engagement for URMs and ultimately may contribute to their high rates of attrition. The research concluded that demeanors and attitudes of professors often implicitly and explicitly convey messages which influence the engagement of students in the classroom and that those professors employing humor, demonstrating genuine care for their students and subject, and exhibiting a passion for the material are likely to be viewed as highly engaging

(Gasiewski et al., 2012). Further, the findings suggested that those professors who utilize active learning pedagogies, employ new technologies to deliver and illustrate new content and strategies, and provide immediate student feedback resulted in student outcomes which displayed stronger conception of the material and greater overall course engagement (Gasiewski et al., 2012). Likewise, over four hundred STEM declared majors who did not switch majors were compared with those who did switch majors in Seymour and Hewitt's (1997) seminal study across seven universities. The results concluded that the unwelcoming culture in the discipline had far more to do with students leaving the major than any lack of student ability or preparation (Seymor & Hewitt, 1997). More recent research has also highlighted how better student experiences and positive attributes of the schools in question significantly increases URM attainment in STEM fields (Gasiewski et al., 2012; Palmer et al., 2010).

Several studies have also proved that initial high-end college experience led to research with faculty that exposed students to the process of graduate level research and influenced URMs towards their decisions to pursue graduate degrees (Harper, 2010; Palmer, Maramba, & Elon, 2011; Slovacek et al., 2011). The increased belief in oneself to succeed in college, or "self-efficacy" increase, is a peripheral benefit of such programs that also serve to provide experiences allowing students to determine career goals (Johnson, 2011; Majer, 2009). Linear regression models applied to data from longitudinal studies conducted by Majer (2009) suggest that self-efficacy for education correlates to high degrees of optimistic attitudes and feelings of control over problems that arise in one's life. Research validates that confidence in one's own abilities is notably lower amongst Latino and African American populations (Majer, 2009). Self-efficacy, Majer (2009) insists, is not limited to any individual subject in higher education and can be increased over-time with a warm acclamation period or program that fosters a welcome

environment while teaching the less than obvious rules to the game for successful degree completion. Similarly, research by Kendricks (2011) shows that computer based mathematics learning can improve URM student learning by as much as 15%, as long as it is delivered within a warm environment by an instructor who is perceived as caring.

Bridge programs and mentorships (Johnson, 2011) that appear to aid in positive self-efficacy need to be supported and developed at institutions that have still not realized the value added by such implementations (Palmer et al., 2010). According to Ghosh-Dastidar and Liou-Mark (2014), whose grant funded three-tiered mentoring design system has shown strong results for URM students intending to head to graduate school, the highly effective practice of positive mentoring by peers and other academic mentors is one of the most important factors for increasing engagement, motivation and ultimate retention for URMs in STEM. Perhaps more labor intensive and costly, but seemingly effective, are living-learning programs that have been researched for their value in building intense community among participants (Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). The researchers of the previously noted study caution that causality is of course difficult to determine, however the drastically increased persistence numbers of such culturally inclusive communities of URMs seem worthy of further investigation (Soldner, et. al, 2012).

Borrowing from the Inclusive Cultures of HBCUs

There is likely no clearer example of the positive effect belonging has than at historically Black colleges and universities that consistently turn out better numbers of URMs than their comparative peers at predominantly White institutions (Museus & Liverman, 2010). Research shows that various peer-assisted models, where URMs work with other students as mentors with positive self-images and higher self-efficacy, have produced excellent results on urban campuses

with greater than average numbers of URMs (Lansiquot et. al., 2011; Majer, 2009, Myers & Pavel, 2011). Kendricks & Arment (2011) report on Central State University, an HBCU, which has developed a K-12 model that stresses a nurturing and comfortable environment they have created within their *Scholars Program*. The program features six mentoring activities that solidify the scholars' academic backgrounds, building self-esteem and adding to their professional identities (Kendricks & Arment, 2011).

The Morrill Act of 1890 first authorized that public funds would be provided for states denying admission to their institutions that were previously granted land by the federal government (Scott, 2006). Today, schools with an urban mission, Scott (2006) argues, continue as an extension of the tradition of the land-granting schools serving the needs of the rural communities and their resident students, which took place in the 1800s under the Morrill Acts. Hip Hop culture already provides a welcoming and familiar culture for many URMs and could readily be implemented within many urban institutions and STEM curriculums (Emdin, 2010). Practitioners at the high school level have already found great deals of success incorporating Hip Hop based educational models which help to scaffold traditionally ominous topics, while raising social and critical consciousness and increasing student engagement (Duncan-Andrade & Morrell, 2005; Hill, 2009; Lyical, 2013; Stovall, 2006). However, it may be argued that without more consistency and better preparation at the K-12 level there will simply not be enough URMs on campuses in the first place to strictly worry about persistence issues.

Strictly researching the noted success at many HBCUs is perhaps to already assume that students and families of URMs have either received the necessary scholarship or financial aid, or have the ability to pay for college to get to these promising campuses. Studies have revealed the fact that financial affairs seem to be one of the most daunting tasks, and ultimate predictors, of

whether or not URMs will ultimately leave a college campus before degree attainment (ASHE Educational Report, 2011; Palmer et al., 2010). Since many STEM initiatives were funded with mixed results at the national level, perhaps rewarding those institutions (and ultimately its students) doing an exceptional job with funding from national grant monies would have more of an immediate positive impact upon the current dilemma of low URM STEM degree attainment. Incentivizing the rate of graduates in the STEM sciences for URMs could go a long way towards attracting and retaining more diverse students who are able to persist (Melguizo & Wolniak, 2012).

Clearly, a stigma-free concerted effort to graduate qualified college candidates from more urban high schools must also be considered in any plan to improve the numbers of URMs on college campuses graduating with STEM degrees. Additional roadblocks also include the stigma of would be scientists maintaining their "Blackness" while seeking such predominately White associated degrees (Hurtado et al., 2010; Palmer et al., 2010). Though there is much more to be potentially learned from the ideal case-study scenarios that HBCUs are able to lend to study, it would seem logical that HBCUs, and other similar (yet traditional) universities and colleges with a metropolitan mission and focus on such "urban" needs, would be a strong fit for students looking to embark on careers in the STEM sciences (Hall & Martin, 2013).

While more research focus needs to be placed on HBCUs and community colleges, where high rates of successful minority degree attainment has been found to occur, strategies should emerge based upon best-fit, which potentially will best serve those institutions positioned to adapt accordingly (Charleston, 2012; Museus & Liverman, 2010). Clearly, it is also important to determine if other lurking variables or hidden factors are at work helping URMs to succeed at these types of institutions before attempting to replicate these practices at other types of

institutions as well. Lessons learned from successful STEM degree granting institutions such as HBCUs, community colleges, and other schools that welcome and build common cultures for URMs are worth exploring further for the potential solutions they stand to offer.

Hall and Martin (2013) succinctly summarize the impact Hip Hop pedagogies can have, while also imploring the value of what PWIs can learn from HBCUs. Their findings demonstrated the importance of positive school climate for African American student engagement while arguing PWIs also stand to learn a great deal from HBCUs in terms of building more inclusive climates for African American students. Hall and Martin (2013) provide examples of how it is typical for non-HBCUs to have minority student retention offices and offices of diversity relegated to "one, often understaffed, under budgeted office" (p. 103). While PWIs tend to pride themselves on the food, music, and clothing of cultures put on display for certain diversity initiatives, Hall and Martin (2013) note that at the particular HBCU they studied it was clear that the African American students felt a true sense of value every day, and not only during certain diversity initiatives. This research underscores the importance to assess campus climates holistically and, where necessary, to make systemic changes across the hiring and promotion procedures, as well as the need to comprehensively assess curriculum development practices as a safeguard to guarantee a culturally and socially responsive environment is being developed and maintained (Hall & Martin, 2013).

Modeling the Culture of Hip Hop as a Relevant and Engaging Learning Environment

Students who feel a sense of belonging persist at institutions where they are among the select few in their chosen majors such as the STEM disciplines (Harper, 2010). Campus climates and higher educational institutional environments and cultures play unmistakably important roles in helping to frame experiences as favorable or unfavorable for URMs in STEM (Allen-Ramdial

& Campbell, 2014). Clearly campus culture of PWIs and the prevailing climate within the various STEM departments plays no small role in helping to determine URM outcomes, especially when URMs are among the very few normally represented within such departments (Museus & Liverman, 2010; Slovacek et al., 2011; Allen-Ramdial & Campbell, 2014).

A college campus infused with at least an appreciation for the culture of Hip Hop that many of its young urban students already identify with would serve as a powerful strategy for certain well positioned schools to effectively attract, retain, and ultimately produce more URM graduates. Perhaps funding Hip Hop based projects that aim to make STEM "cool" and rewarding through engagement with local and national artists could be one initiative that would speak to a large portion of the urban demographic before choosing a college or a career path.

It will likely take a concerted effort of likeminded researchers, practitioners and policy makers at the systems level to help improve the rate of URM graduates in the STEM disciplines. The same things that are often described as engaging by students from diverse cultural backgrounds, such as music, video, graphic arts, the Internet, and interdisciplinary courses are the very same things missing in most of the K-12 public schools where students are supposed to be developing academically, socially, and culturally (Charleston, 2012). Research by Charleston (2012) qualitatively investigated the factors that led to a URM choosing computing and science based degrees as majors in college. Results proved to be centered on students' early exposure and engagement with computers, computing in general, and the rigorous prior grounding of science and mathematics by caring educators (Charleston, 2012). The relatively low amounts of African Americans choosing similar career paths may point toward the frequency of inadequate preparation at the K-12 level due to inadequate staffing and readiness of technology and equipment which serves to make math, computers, and science fun and engaging (Charleston,

2012). It is for this reason a variety of traditional high school subjects have been listed as possible places to incorporate studies rich in Hip Hop culture to help improve interest, critical thinking, and test scores among diverse urban students across a multitude of subjects (Morrell & Duncan-Andrade, 2002).

Research by Edmin (2011) takes the idea of shared culture further by imploring urban high school science instructors to recognize the value in appreciating the culture of Hip Hop that most URMs commonly share. Hip Hop as a culture is a readily available conceptual tool that science educators ought to be familiar with to harness the untapped potential energy those who feel marginalized by science often bring to the urban classroom (Brown, 2010). Hip Hop (and its voice through rap music) is largely the culture and language of urban America and is a global phenomenon (Ewing, 2014) educators ought to be embracing in their classrooms (Emdin, 2011; Hill, 2009). Further, instructors ought to provide students with an example of how a reflective and culturally aware citizen may engage dynamically with one's personal passions in the outside world (hooks, 1974; O'Brien, 2000). Any lack of this from an educator may be perceived as "not real," something determined by students extremely early on in the course, while setting up educators for failure if they do not appreciate students from Hip Hop cultural backgrounds who judge value by how "real" the messenger and the message appears to be (Hill, 2009). Only then, may experiences bring the curriculum alive and illuminate the material in the most meaningful way possible, especially for URM students.

The concept of educators utilizing Hip Hop to build culture familiar with the students is certainly not limited to pre-college experiences. The incorporation of Hip Hop culture in higher education has been one of the more recent key inspirations for CRT pioneer, Gloria Ladson-Billings (2014). Ladson-Billings' (2014) musings on the subject, in an article she authored for

The Harvard Educational Review, which she entitled "Culturally Relevant Pedagogy 2.0: a.k.a. the Remix" in a clear nod to Hip Hop, reveal her newfound appreciation for Hip Hop culture in the classroom. Ladson-Billings (2014) documents how her work with an innovative spoken word and Hip Hop arts program, *First Wave*, at the University of Wisconsin-Madison was an ideal opportunity for progressive growth, expansion, and positive change. In the fall of 2007, Wisconsin-Madison's Office of Multicultural Arts Initiatives (OMAI) implemented a program of scholarship tasked with supporting a learning community of spoken word artists by fully integrating the culture of Hip Hop into the academy (Ladson-Billings, 2014). Ladson-Billings (2014) chronicles how her undergraduate teaching changed drastically for the better resultant of working with this Hip Hop program, as it provided her with a reflective opportunity to make changes in her undergraduate teaching while challenging the way she and her students interpret, learn, and perform in academia and the rest of the world.

Through the outlet Hip Hop provides across its four main elements of B-Boy/B-Girl dance (commonly known as "break dancing"), Graffiti art, Emceeing, and Dee-Jaying, many active participants in Hip Hop culture are able to find their own voice and often positively impact the communities they are often called to "represent" (Hill, 2009). That which is true for Hip Hop artists who rap or dance is the same truth shared by other artists in "the cipher" and at live shows and/or on recordings (Cytrynbaum, 2010). The common bond of a cipher, a communal gathering of artists in a circle where each take turns displaying their talents, is discussed at length by Edmin (2010) while arguing how science educators might be more successful by also evoking the power and camaraderie of the cipher in the classroom. The new improvisational twist or contribution made by the next artist in the cipher is valued as the personal expression of truth and identity—and is supremely respected (Cytrynbaum, 2010). Though the dominant players in the

cipher do become known, very often it is the idiosyncratic tendencies of the other participants that manage to make an even greater impact than the skills of the most competent master craftsmen occupying the center of the circle for the longest—in other words, participants (including faculty) are equals while in the cipher based classroom (Emdin, 2010).

The opportunity to incorporate the power of the cipher was not missed by Ladson-Billings' (2014) either; in her work she reveals how all of her students would participate in a final cypher. Ladson-Billings (2014) explains how she allowed her students to form their own groups, including both First Wave and non-First Wave students. Attention is paid to how the education research they studied could be blended with the relatively new cultural form of Hip Hop and the cipher, which clearly consumed a great deal of her students' lives and world views (Ladson-Billings, 2014). Emdin and Lee (2012) make the case that subtle nods of approval like these from educators, whom either lived or at least respect Hip Hop culture, are often all that are needed to engage a learner. Citing how when Obama "dusted his shoulders off" on a national stage, or when he and his wife publicly gave a fist-bump, Emdin and Lee (2012) argue that many students watched and interpreted this as Obama being *down* with Hip Hop. With Obama publicly endorsing a greater emphasis on STEM subject matter, young marginalized youth who also embrace Hip Hop culture (and Obama) may also follow suit and become more likely to consider a future in the sciences (Emdin & Lee, 2012).

Critical theory, as it is applied to a Hip Hop ideology, is paramount to be able to effectively reach and teach the traditionally under-represented minority student (Hill, 2006). Many of these students are already skeptical of the role of governments and institutions and the system in general and without building this form of community they will only become harder to reach (Edmin, 2010). It is not the educators' place to impose their long-held view of the world

upon the student; rather it is open dialogue (much like that found within the Hip Hop cipher) that will make the curriculum come to life with students as active participation in its development (Freire, 1970). This focus of this portion of the review is not to suggest that all schools will be a natural fit for a cultural backbone such as Hip Hop to be the dominant ideological strategy infused within a particular college or program within it. For this reason, it is possible a higher educational program of this type may best work in the future as its own free-standing institution. With further investigation into which schools are continuing to produce high amounts of graduates in the STEM fields, and by examining their successful practices, some of these same processes could be implemented at other like-minded institutions. However, there is no free-standing institution currently using Hip Hop pedagogy as its primary means to deliver meaningful STEM based content; how this would look in a delivery model is strictly a theory of this researcher at the moment.

Though this literature review is focused specifically on URM students, it is quite likely that "who" the URM is in terms of racial and ethnic identity will likely change as the landscape of the nation continues to become even more diverse. One galvanizing feature of Hip-Hop *music* (or rap) as Emdin (2010) notes, is that it speaks to the marginalized individual across all races who has been involved in socio-political struggle. Further, it speaks increasingly more to those who generally understand struggle of any kind or those appreciative of the art form and culture (Lyrical, 2013). For these reasons, as the nation continues to change racially in terms of what groups are defined as the most under-represented "minority" or populations, it is likely that Hip Hop culture will continue to be a shared and respected lifestyle that unifies urban students, which educators should continually look to learn from (Brown, 2010; Emdin, 2010; Emdin & Lee, 2012; Hill, 2009; Lyrical, 2013; Morrell & Duncan-Andrade 2002).

Summary

Preparing students for success in a rewarding postsecondary education should not be a luxury. College is, now more than ever, a necessity for life that helps ensure the continued well-being and prosperity of all the nation's citizens as this nation competes on a global stage. Though there does not appear in the literature to be one clear solution, or "magic bullet" that will help rapidly improve the STEM crisis in America, there certainly are many factors that appear to correlate with success in STEM degree attainment. For URM students, there are several examples of how methods utilized by HBCUs and the infusion of Hip Hop culture have been successful to increase interest in STEM courses, as well as other subjects. The process starts well before college, and any solution needs to recognize the inadequacy of several schools' inability to produce satisfactory mathematics and science results in many of the nation's poorest districts (Metcalf, 2010).

Regardless, college must become an even greater goal in the nation today than obtaining a high school diploma was for much of the last century. Yet traditionally underserved students are derailed by limited access to affordable, quality educational options that will yield rewarding futures. Further, evidence from research suggests that URMs have different motives for attending college in the first place that also make their adjustment more difficult than for non URMs (Majer, 2009). Directing resources towards improving teacher development and technology support in under funded programs would be a starting point to focus attention. Since role models have been shown to work at the college level and in summer bridge programs, following through with this theme while students are still early in their K-12 careers would seem to make sense (Hagerdorn & Purnamasari, 2012; Johnson, 2011). It will likely take a concerted effort of likeminded researchers, practitioners, and policy makers at the systems level to help

improve the rate of URM graduates in the STEM disciplines. The following chapter will illustrate how narrative inquiry is the most desirable method to extract meaningful stories from URM students concerning causes of attrition out of STEM courses of study in higher education institutions.

Chapter III: Methodology

This study addresses as its problem of practice the lack of underrepresented minorities who successfully graduate with degrees in STEM disciplines. Further, this study examines how individuals from these same underrepresented groups often become marginalized victims of STEM attrition at rates that exceed their traditional (White and Asian) counterparts. URMs frequently possess vast social and cultural capital in the area of Hip Hop culture, yet STEM instructors often fail to tap into Hip Hop as a pedagogical tool in the classroom. If this changed, it would almost certainly inspire and motivate the masses of students who are familiar with, or are products of, Hip Hop culture—yet largely still remain underrepresented within the STEM pipeline (Emdin, 2010, 2011). Key rationales for this study, then, include examining how attrition among URMs may be a reaction against the pervasive cultural norms that run counter to the norms of this segment of the larger population while investigating historical problems which continue to lurk within STEM higher education departments (Creswell, 2013). To address these problems, a narrative methodology is developed in order to capture the unique experiences of URM students who have either left higher education or switched out of STEM majors.

Research Design

One key role of the researcher is identifying assumptions governing preexisting viewpoints in relation to the given phenomena being observed; this will inevitably help shape what can be known while forging ties to a favored methodology (Butin, 2010). Creswell (2003) explicitly calls for researchers using qualitative methods to relate a given research question (or questions) directly back to the chosen methodology. While quantitative methods (such as a bivariate analysis) could likely show STEM attrition being correlated with a wide range of factors, qualitative inquiry allows this researcher to investigate the "how and why" surrounding

the high rate of URM attrition within STEM disciplines (Creswell, 2003, p. 106). It is important to evoke the emotional side of the stories of those marginalized in society, especially since this aspect is often overlooked when examining science and mathematics based degree attainment. This point is essential for this researcher's methodology since either STEM attainment or attrition reports are largely for (and by) scientists and mathematicians, often ascribing to post-positivist reductionist ideologies that often skip the cause and effect nature of such problems (Creswell, 2013). Not surprisingly, there is a lack of qualitative research in the literature involving narrative inquiry to account for the experiences of URM students who have experienced unfavorable STEM cultures, low expectations, racial prejudices or other biases during their higher educations. This study helps fill such a gap.

Qualitative research in the tradition of narrative inquiry has a power in itself to cause us to question our values and policies, and challenges us by allowing us to access our emotion to rethink conventional wisdom and authority. Coulter and Smith (2009) critically address how researchers need to juxtapose such privilege by providing clear voice for the situations the marginalized participants face within society and have lived through actual experience. The researcher should have the flexibility to introduce counter narratives through what Coulter & Smith (2009) call "narrator reliability" (p. 581). This is mitigated by whether or not the researcher uses first or third person narratives, or speaks in an omnipotent or semi-omnipotent voice (Coulter & Smith, 2009).

Though the work of Pinnegar and Daynes (2007) is fairly modern, it is heavily cited material in chronicling several movements that shifted towards narrative as a major force in academic writing once the academy eventually came around to understanding its value in telling rich stories of marginalized people. Their work also draws from the seminal writings of

Clandinin and Connelly (1994), which set in motion the need for academia to understand people's personal experiences. Other traditional research methods were often viewed as stale and static and highly decontextualized before the work (consisting primarily of the researchers previously noted) was accepted as serious scholarly material. The dullness of certain research methodologies then provided the space for narrative analysis to have an entry point into academic research (Huber, et al., 2013).

Research Tradition

Casey (1995) covers the origins of narrative inquiry by providing clear examples of narrative analyses which all stem from progressive political events and situations. Anti-racist movement narrative, feminist studies, and gay/lesbian (queer) studies become part of the history of narrative discourse—traditions which also mirror the origins and lineage of CRT itself (Delgado, 1989; Villalpando, 2004). Narratives, therefore, have the power to tell counter-stories that push back against the oppressor (Friere, 2007). These stories offer resistance against the narrowly defined social, cultural, institutional, dominant narrative which defines meaning within public education and the university as merely test score results and compliance—instead of the actual lives of the often marginalized whose real stories go silenced (Huber, Caine, Huber, & Steeves, 2013). Narrative inquiry and CRT are well-aligned and have been paired together in at least one case-study research inquiry focusing on Hip Hop pedagogies at an HBCU (Hall & Martin, 2013).

Narrative inquiry has not been without historical controversy in educational research, yet over these years it has emerged as a power tool capable of providing rich proximate examinations of the teaching and learning process (Barone, 2009; Ladson-Billings, 1998, 1999; Martin, 2014; Riessman, 2008). When Clandinin and Connelly (1994) developed the idea of

narrative inquiry as a research methodology, it was largely informed by the preeminent education philosopher of the 20th century, John Dewey (Huber et al., 2013). Since the early to mid-1900s, Dewey was instrumental at promulgating the idea that studying one's education *is* to study experience. Narrative methods are likewise very effective in allowing various interpretations by different practitioners to emerge (Coulter & Smith, 2009). Ever since Einstein proposed the theory of relativity (not long before Dewey's key works on education and experience), the general public has become cognizant that two people will observe a certain phenomenon and literally experience it in two different ways. This difference of opinion for various subjects in such a study is problematic for narrative researchers, but, when allowed to develop properly, it adds great richness and detail to stories (often under-told) by incorporating varied perspectives (Huber et al., 2013). Now that narrative inquiry has grown in acceptance (Riessman, 2008), it is quite common to be the chosen methodology exhibited across various disciplines such as nursing, medicine (and health fields), social work, law, and of course education (Clandinin, 2007).

While Casey (1995) suggests that narrative researchers maintain an excellent opportunity to defy the powers that be in their attempts to marginalize and fragment, Barone (2009), a narrative researcher and defender, does give a word of caution to scholar-practitioners privileged enough to retell stories of those who may not have the ear of the academy at their disposals. While on one hand, the researcher employing narrative inquiry often empathizes with the plight of the marginalized, Barone (2009) warns that the authentic voice of those providing the narrative must not over polish the final product, or push too hard for their own political agendas—something which those employing narrative inquiry have on occasion been accused of doing. Pinnegar & Daynes (2007) follows this implication by questioning not only who should

have the right to tell the story, but inquiring as to who will be able to effectively disseminate it in a convincing matter to elicit a necessary systematic change.

Coulter and Smith (2009) suggests that narrative research often hits a wall, namely when critics ask the question "Did it really happen the way you claim or say it did?" Barone (2007) provides an outlook which nullifies the common critique provided by Coulter & Smith (2009) by positing since all human understanding operates and is confined to power relationships (which define the way the knowledge is interpreted) it becomes the duty of the narrative researcher to qualitatively redress all such power imbalances and reconstruct the relationships during the course of disseminating the findings. Though the interpretation of any experience is somewhat subjective once translated by a researcher, it is clear that ethical considerations become prime directives for narrative researchers and should undergird all phases of the inquiry process (Clandinin & Connelly, 2000).

Participants

Creswell (2013) claims that for narrative research to blossom "the individuals need to have stories to tell about their lived experiences" (p. 155). The central idea being who to sample is extremely important in order to allow the stories to develop properly. It is not uncommon with narrative inquiry to interview only a very small amount of individuals, sometimes as few as one or two (Creswell, 2013). This study uncovers the stories of four URM individuals (two males, and two females) who attended, or still attend, an institution of higher education while majoring in STEM and either withdrew from the institution before completing their degree or switched out of their initial STEM degree programs.

Sampling. To allow for a rich analysis and narrative to occur, this researcher realizes the sampling strategy for narrative research often requires fewer participants than other traditional

methods. This researcher believes purposefully finding participants with an interesting story to lend to this unique study requires participation from four individuals—instead of the more common one to three participants more commonplace in narrative studies (Creswell, 2013). However, all of the participants were found relatively easily and a natural balance occurred between the types of participants. Two female participants were interviewed; one whom is currently a student at Northeastern University and another who graduated from another selective institution in the Northeast and went on to also earn a graduate degree as well. Similarly, two males also participated in the study; one was a former student of Northeastern for only his freshman year (in Foundation Year) and transferred to multiple colleges afterward. This student has not earned any degree as of this point. The other participant earned an undergraduate degree on the West Coast and later attained a masters and doctorate degree as well. These four individual stories have been incorporated into this study, while ensuring each perspective has been captured relative to the different natures of each student experience.

  Recruitment and access. Recruitment of URM individuals, currently or previously majoring in STEM, took place electronically. Targeted recruitment took place through a call for participants residing in the vicinity of Boston, Massachusetts. One former student of Northeastern and one current student of Northeastern were chosen, along with two former STEM undergraduates who previously attended other institutions. The final participant [the one current Northeastern student] came as a result of this researcher attending an event at the John D. O'Bryant African American Institute on campus at Northeastern University. The Ujima Scholars program this institute operates selects a small cohort of predominantly URM students from all over the country to welcome into its family, which provides support for undeclared freshman. The students transfer into one of the colleges on campus after selecting a major and

receive various supports from the institute throughout their time at the university. This final participant was also electronically recruited after hearing her experiences discussed at the event, which spoke directly to how she had been a science major and had later switched out for various reasons.

This researcher's own Northeastern University program within the College of Professional Studies— Foundation Year (FY)—is a freshman year cohort model for students who have graduated from Boston Public Schools. Approximately 80 students each year are accepted into the FY cohort, which predominantly consists of URMs. Contact is maintained with the vast majority of students (per signed agreement) after they transfer out of our program and leave to attend other institutions. Since FY is a one year program where students start as undeclared majors, nearly all students by definition have left to attend other colleges or universities and have entered into various declared major programs. The vast majority of students in the program are URMs from Boston (in this case, almost exclusively from the inner city), many of which have entered into STEM majors and some of which have changed majors.

With cooperation from the Director of FY at the College of Professional Studies at Northeastern University, this researcher prepared an electronic call for participants formerly involved with this program (See Appendix A: Letter of Introduction). This produced one of the participants for the study, whom this researcher had never previously had the opportunity to meet before the interview. The other electronic call was more general and went out to other potential area participants.

Data Collection

The data that is amassed in a narrative needs to be analyzed properly to allow an unfolding chronological account of events in the given participant's life which often lead to the

turning point in the study—in this case—attrition from a STEM based degree program (Creswell, 2013). Through interviews regarding the individual's particular life experiences pertinent to the event of leaving the major, the researcher has attempted to place these experiences in their proper historical contexts as suggested by Creswell (2013). This research utilized semi-structured formats, which encouraged interviewees to answer at length and in detail based on prepared and follow up questions (Saldaña, 2012). Considerable time often needs to be spent with each participant to potentially allow stories and situations to properly unfold, as well as to ask for follow up detail questions that provide for rich and detailed description (Creswell, 2013). For this reason, these interviews all lasted approximately ninety minutes and provided clear understanding and detail illuminating each individual's experience. The interview questions were consistent across the four interviews, however additional clarifying questions were asked for follow up and clarity depending on the nature of the given responses (See Appendix B: Research Questions).

Building trust is also based on time spent with others as well as mutual respect. From the initial contact, it was made clear that the motivation to talk about such potentially sensitive information is to improve the landscape of STEM by improving the numbers of URMs who are able to enter the field (Creswell, 2013). At the conclusion of the data collection phase, memo writing and multiple rounds of coding (Saldaña, 2012) helped this researcher negotiate the overall meaning of the story. The process also included solicitation of the participants' feedback to add more value to the final narrative and improve the credibility and accuracy of the story (Creswell, 2013; Lincoln & Guba, 1985).

The coding was done with the help of QDA Miner coding software which enabled fast accurate themes to be gleaned from the interviews which were extracted from digital recordings

by a transcriber. However, this researcher additionally coded the data by hand with multicolored highlighting to compare the quantity and quality of responses that contributed to each theme and led to an additional round of coding. This allowed for a more holistic understanding of the context of each response and permitted the stories to fully develop and merge thematically where applicable.

Interviews. In cross-ethnic interviewing, Creswell (2013) explains how interviewees are sometimes motivated to explain such ethnic experiences to others, and how being familiar with the interviewer ahead of time would be a definite advantage. Though not a URM, this researcher was previously familiar with two of the participants in the study; this allowed for mutual trust and ease of conversation throughout the process. The other participants were also made aware of this researcher's particular background experience, familiarity with Hip Hop culture, and motivation for the chosen topic, which also helped create more mutual trust and openness.

The ideal location for such interviews is a discrete place where both the interviewers and participants in the study are comfortable (Rubin & Rubin, 2012). Each location was chosen by the participants to ensure maximum comfort. All participants were met within minutes of a central location on campus convenient for each member of the study to attend and participate.

Data Storage

These four digitally recorded and transcribed interviews were conducted in one session of approximately ninety minutes each. The participants were identified as "former students of STEM based majors" at either Northeastern or elsewhere and were given pseudonyms as needed. No actual names were utilized in the study, and any identifiable information gathered or recorded during all interviews was categorically removed from transcription of these interviews. Data has been stored in paper form (and on a digital recorder) in a locked briefcase, and via a password

protected laptop computer. All digital recordings and digital and/or handwritten transcriptions of data is to be destroyed at the conclusion of the research process.

Data Analysis Process Overview

Clandinin and Connelly (2000) use a three dimensional approach to analyze data which seeks to identify: the situational aspect of place, the mode of social and personal interaction, and the continuity of what is revealed in terms of its past, present and future. Coulter and Smith (2009) describe this approach as "an analytical process that is artistic as well as rigorous" (p. 577). Creswell (2013) citing Denzin (1989b) explains that through journaling and sketching an individual can approach these same stages and experiences that will unfold chronologically. This process during interviewing allows for expansion of these ideas and often leads to asking (and directly asking for) the participants to theorize about their entire life circumstances in terms of a loose biography that unfolds and allows the researcher to find patterns of meaning for various narrative segments of the study (Creswell, 2013).

Data Reduction

The audio-recorded interviews were converted to text by a professional transcriber. This transcript was then explored and coded for analysis of themes that classified and interpretively described the data (Creswell, 2013). These codes served as prompts for reflection on deeper concepts and meanings elicited in the interviews (Saldaña, 2012). The first round of coding was conducted to extract themes from each participant, which emerged from the full digitally recorded interview with each member. The second round of coding was conducted with the purpose to compare themes across the study holistically, while helping to derive meaning from the entirety of the data. The broad categories that emerged throughout each interview were then crystalized in Chapter 4 of this study with an actual quote from each participant. A cross

participant analysis captures the essence and many similarities of these themes in Chapter 5, and those similarities are then blended into a piece of poetry written by the researcher in the tradition of rap lyricism.

Trustworthiness

Though maturation in the classic sense may not impact this study, there is some room for a maturation effect to impact it. Since participants reflected on issues that made them switch out of STEM majors, it is possible that their own maturation since the time of switching the major may be a factor. For these reasons, questions were framed to help ensure that participants were not speaking from their current interpretations of the problem as more experienced students "looking back" on their earlier selves. However, it was clear that issues pertaining to both the former and current students were extremely similar in many aspects and were readily recalled in every case.

Lincoln and Guba (1985) provide indicators of trustworthiness for all qualitative research: conformability, credibility, and dependability. For the narrative methodology, which underpins this study, there is emphasis given towards the credibility of the results of the research. Creswell (2013) suggests using multiple variation strategies to ensure trustworthiness through credible findings. To extract an overall theme that results from a research study Creswell (2013), citing various techniques from Whittemore and colleagues (2001), highlights eight particular strategies of validation. None of these, however, has been more important to this study than clarifying researcher bias.

There was no instrument change in the interviews or any testing differences. Location was safe and convenient. It is important to recognize that although all threats are never guaranteed to be eliminated entirely, researchers should at least honestly attempt to keep any

such occurrences to a minimum whenever possible. By continually monitoring reliability and

validity threats the trustworthiness of the research has been maximized.

Credibility. Triangulation has helped to ensure the validity of the results. Looking at

evidence from different vantage points helps to ensure true patterns are emerging from the data

and not from unchecked bias or assumptions. This researcher is fortunate to have peers who have

already received their doctorates, some of whom have researched similar issues in education

concerning how marginalized groups have navigated academe. For this reason, peer-reviews

with two of these individuals served as a sounding board to ensure the methods and

interpretations of this study were solid. To also help reduce error, participant input was solicited

via member checking (Creswell, 2013) as an added measure of accuracy, assurance, and

credibility. Electronic communication has helped this researcher share information from the

preliminary data with the participants to clarify any potential misinterpretations.

Protection of Human Subjects

Research must be undertaken in a manner to pose no mental or physical danger to study

participants. To guarantee this, and to fully protect student rights, this researcher obtained

permission from the necessary Institutional Review Board(s) (IRB) before beginning the study.

An interview protocol for this study was developed for semi-structured interviews that

were audio recorded and transcribed. The transcript was explored and coded for analysis of

themes, followed by a narrative describing the essence of the participants shared experiences as

well as an interpretation of the findings. Interviews with participants were designed to be non-

intrusive to ensure that when participants answered questions about their experience as STEM

majors they were comfortable answering all such questions. This helped to provide a clear

picture of their experiences. Confidence and trust in the researcher was key for participant comfort throughout this study.

To help address any potential ethical challenges before they came to fruition, this researcher obtained completed informed consent forms from every participant in the study (See Appendix C: Unsigned Informed Consent Document). No participants were under eighteen years old, therefore ensuring no "children" were involved in the study. This researcher provided all participants with both verbal and written explanations of the purpose of the research in concise language and wording that was transparent (See Appendix C: Unsigned Informed Consent Document). The participants were informed of their right to end their involvement at any time during the study had the nature of the conversations become too revealing or stress inducing for any reason (See Appendix C: Unsigned Informed Consent Document). In contrast, two participants mentioned how the study was revealing and served as a "therapeutic" experience for them as well.

It is of the utmost importance as a researcher that measures are taken to safeguard confidentially for study participants (Rubin, 2012; Creswell, 2013). Many URM students who have switched majors from STEM fields may be more easily identifiable if the previous institutions were to be named. By definition, former and current URM students are underrepresented minorities, therefore they may represent a very small number of minority students at a given campus who studied within their given STEM discipline. However, even when students' names are left out, others in their field potentially may recognize them. For this reason, participants were warned ahead of time of this reality, but this researcher has taken necessary precautions to leave out parts of the story, which would otherwise render these students especially identifiable due to certain unique particulars (Rubin, 2012). Nearly all of the

participants in this study were not heavily concerned with being identified however, since in their opinion nothing was being stated that was very harming to previous or current institutions (or about themselves). Still, students have only been identified by single named pseudonyms to eliminate any unforeseen problems. No specific names therefore have been utilized in the study and any identifiable information gathered or recorded during all interviews was categorically stricken from transcription of these interviews. Any digital recordings or data will be destroyed at the conclusion of the research process.

Chapter IV: Research Findings

This study was conducted with the purpose of helping to increase degree attainment among URM students majoring in STEM disciplines at predominantly White institutions, principally by understanding the key factors which led to their attrition out of STEM. As a secondary purpose of this study, this researcher examined the cultural experiences of URM students initially enrolled in STEM degree programs who also identified with the culture of Hip Hop in order to ascertain the perceived usefulness of including elements from Hip Hop culture into STEM curricula, pedagogical delivery, or overall culture within STEM departments or the campus culture as a whole [a STEAM initiative by definition]. Another practical purpose of this study is to better understand how URM students might be better served within higher education classrooms and campuses to ensure greater numbers successfully enter the STEM workforce with a meaningful credential.

This study directly considers the lived experiences of four individuals from historically marginalized populations to better understand how higher education institutions might more effectively reach, retain, and ultimately graduate, URM students majoring in STEM. This chapter is composed of the narratives developed from the shared stories of these four participants, all at various stages in their academic and professional careers.

Dana's Story

Dana is an African American woman from the Midwest who was raised in a predominantly White environment. She was a slightly above average high school student who pushed herself through an assortment of AP courses, yet did not receive the same push from her teachers and administrators. She did, however, go on to attend and graduate from college after a transition out of her initial STEM degree program halfway through her studies. Upon discovering

she was a strong writer and deep thinker, with more in common with communications and sociology majors than biology and chemistry, she made the leap out of STEM. Dana found this new culture to be much more cooperative and inclusive than the cut-throat atmosphere and highly competitive nature within the STEM program she originally entered as a freshman.

Dana also went on to receive her MBA from another highly competitive East Coast institution. She is now employed by a major university in Boston. Prior to becoming a successful college undergrad and grad student, she attended a K-12 school system where she was perennially one of the few Black children in her schools and classes. Her parents, however, were very motivated to help her succeed, as she would be one of the very first in the family to have a real shot at succeeding in college.

This is your ticket out. Dana explains the environment in which she grew up, and her initial motivation to pursue a STEM degree, along with the ensuing struggles exacerbated by some less than inspiring instructors.

> They [her parents] always pushed me through a lot of AP courses a lot of, you know, you should try and pick a field where you're going to make a significant amount of money, try to push yourself into something challenging…I remember being pushed through like math, I struggled with math. I remember not doing so great at calc because I remember having a not-so-engaging algebra instructor. I remember him being a bit of a hippie. Yeah, you know, "let's just have fun" and, he didn't really teach us anything. So, when I got to calculus, I had an instructor who was, like, "You're smart, your algebra skills aren't there. Take home this algebra book over the summer and take it again." And I took it again and I aced it, no problem. So that and chemistry, I had some instructors who, just,

were like, "You just don't have it. You can, kind of do it." But, they weren't, I don't
remember them really having a lot of faith that I could do it.

Both of her parents had attended—but never completed college. Dana recognizes this as part of a
comparative advantage she had over some people's family situations, but she begins to expand
on her own upbringing to explain how it still was less than ideal.

Dana's father had attempted earning a degree but never successfully completed his
program. Her mother had received a full scholarship to attend college but never was able to take
advantage of it because she became pregnant with Dana's brother. Dana, accordingly, felt extra
pressure to attend and do well in college, on top of some extra obstacles she was being forced to
deal with.

They were, like, "This is your ticket out. So you need to push yourself." And they were
very strict with me, specifically my father. So I could not leave the house unless I had
perfect grades. Things were done, like it was a little too strict in my opinion. I also held a
pretty solid job to help my parents pay bills when I was kid, and came from a pretty
severe upbringing. I came from a low socioeconomic background. My father was
disabled, he had a severe accident at his university, where it led him to have a lot of
depression issues. I saw him try to commit suicide when I was seven. There were some
severe problems with him and my brother, as well, in terms of just really severe issues
and it's, you know, they, my family, came from, just both of them, a pretty severe
upbringing.

Despite these initial challenges, Dana did get admitted to a prestigious East Coast college. Her
older brother was not so fortunate to have as many options. She recalls that though he is twelve

years older than her and also attended an area college as a STEM major (information technology (IT)), he never did graduate due to several obstacles he faced.

Dana's brother was raised predominantly by her mom since their father left the household when Dana's brother was only eight years old. However, their dad came back to live with them several years later when Dana was born. The relationship strains in the family were harder for her brother to overcome since things had gotten progressively worse, nonetheless, he did go on to successfully open his own IT business and was able to send Dana money while she was in college. This came about after dropping out of his original four-year program, mainly due to a lack of money. However, he was able to take various certificate earning programs along the way through local community colleges which helped him to credibly establish his own business.

I don't remember them being supportive. It was assumed by Dana's advisors and teachers in high school, that like her brother, she would be best off to attend a local state college, and that a prestigious East Coast institution she was dreaming about would be out of reach. They were less than supportive concerning her desire to go somewhere better and more challenging, perhaps buying into the stereotype that someone *like her* did not have what it would take to succeed at a highly competitive college, especially in a science based major.

> I don't remember that being just, come here, let me help you, like, you can do it. I don't remember them being supportive, necessarily. I don't remember [high school faculty and staff] being supportive, necessarily. I just remember just dying and struggling to get through it. I remember really not being able to memorize equations and the periodic table and all of it, it was just so overwhelming. I've never had a great memory. I had to do flashcards and practice problems and flashcards and practice problems and kill myself to try and just get through one exam and it took all of me to try and get through it; AP bio,

AP chem, advanced English, history. I pushed myself, while doing track, while working, and I graduated with maybe a 3-something...So my guidance counselors were always, like, you're an okay student. You're not going to get in anywhere super great...ASU is a good place for you to go. It'll be fun, like, you'll be fine there, but you don't have the money, or our star students go to really nice places in Minnesota, like Saint Olaf. Nobody goes to XXXXX [the college which she later got accepted into].

Dana, of course did not take this advice, nor did she buy into the low expectations. With some encouragement and coaching from her aunt who worked in college admissions, she applied to several competitive East Coast schools and got accepted to all of them.

Dana accepted an offer to attend a highly competitive faith-based college in the Boston area. She entered majoring in biology and chemistry within its science program, which allowed undergraduates the ability to earn the necessary prerequisites sufficient for most pre-med majors—something she was considering. She also was enrolled into an optional summer bridge program which allowed her to consider other careers and majors as well—but she states this program was not a necessary requirement for her to be accepted into a STEM major at this institution. This program afforded her the opportunity to receive some crucial mentoring and supports while earning credits towards a STEM degree—something with a lab where things made sense to her. But her mentoring was mostly not specific to STEM courses.

Why didn't you just have me do this before? Dana attributes her desire to pursue a degree in the sciences to her love for lab-based coursework and playful high school instructors who had the ability to make the material fun, interesting, or game-like. One instructor in particular stood out from all of the others.

I just remember really responding well to instructors who were playful and were, made it

little bit more fun. Like, I remember enjoying physics and I got an A in physics. I

remember enjoying AP bio because I took it—I think I took it pass/fail. So, I mean I

passed it, but I don't think that I was exceptional in it but I remember, I think his name

was XXXXX, and he was young and he took us outside and we did all kinds of stuff and

I just remember doing fruit-fly experiments and I remember that's when I learned that I

was awesome at lab. Lab I got. Lab was my experiential learning component where I

could actually take what I was learning and have a visual physical component to it and

that's when it clicked for me. So, I was, like, "Oh, well now I get it. Why didn't you just

have me do this before?"…That was when I started understanding chemistry and bio and

all of that. So, that's when I realized in high school I was good at lab and that transferred

over to college.

However, once in this prestigious college, she could not help feeling extremely isolated and

disconnected by the competitive culture in STEM. Unlike her best high school science classes,

she experienced college to be the opposite of fun, with the only "game-like" attributes being the

fact that games are also highly competitive. She did find some fun outside of the classroom at

Hip Hop laden dance events, but these were too far and few in between. She repeatedly mentions

the intense competitive nature of all of the science students majoring in "pre-med, pre-dental,

pre-vet, pre-everything" to be highly stressful. She states, "Everyone was better than me. I

remember feeling like I was too slow, I remember feeling isolated."

Why are you setting me up to fail? The feelings of isolation and experiences of

extreme competiveness across her program did not end with just the students, as the instructors

and administrators also seemed bought into this highly competitive normality of STEM degree

programs. Dana soon felt as if she was just too slow, and that her instructors matter-of-factly expected her to feel this way.

> I remember feeling, like, everyone had a head start and I remember feeling like I had to dedicate my whole life to one exam, that I didn't have a chance in hell at and I remember the instructors laughing because they knew that that's how it was supposed to be, and it was like they thought it was some sick joke. I'm, like, "Why are you trying to do this to me? Don't you want me to do well? Isn't this what education is for?" Like, "Why are you trying to set me up to fail?" Like, "Why don't you want me to do well?"

She explains that for the White students, however, instructors would be very forgiving, especially regarding the White male student's performances, saying things like "your fine" or "it's just a fluke." The instructors believed *these* students were supposed to "get it" and would rise to the competitive expectations. But for her—again—she felt acutely aware that some instructors and administrators thought it was normal that as a Black woman she should be struggling in her science and math based courses. She did not receive the same encouragement as her White peers. She explains, "Because of my skin tone it's like, well, you sure this is want you want to do? You know you barely got in, and you probably got in because you're Black. I mean, let's be real."

> Experiences like these led to subsequent feelings of inadequacy for Dana, and began the process of her starting to believe that perhaps she had made a mistake in choosing a STEM major when the rest of her friends in "easier" majors seemed to not only be succeeding, but enjoying the process as well. She recalls these experiences vividly.

> I just started, like, asking myself as I see my, like, you know, history majors off and running and going into Boston to have a drink. You know people are having social hours

and the communications majors are having a blast and I'm still in the library studying and dying and I'm like, this is not what I wanted, this isn't fun, this isn't really what I envisioned why I moved out to Boston and why I'm doing this, and I had a mentor at the time too, thank God.

Being one of the few students on campus who was Black was immediately compounded by being in an even smaller subset of students in STEM who did not reflect much in terms of diversity among the cohort. She recalls a similar circumstance for her cousin, who she labels "a unicorn" to indicate that she simply was not supposed to exist in the real world.

I talk to my uncle now and my cousin who, my cousin made it, like, she's a unicorn. She made it through engineering. Same background as me, [raised by a] single mom, like, disadvantaged background. She shouldn't have made it, either, you know, based on research and what everything says, right? She was a year, she's a year ahead of me. She went to XXXXX, like engineering and she had similar issues, professors accusing her of cheating and all this stuff, like, bad experiences, I mean, and she grew up in an arguably worse environment; bullets whizzing through her neighborhood. She should not be where she is and now. She's an engineer with the Department of Defense and you know, she had her mother, who, again, was pushing her and giving her an environment of support, as well as, my uncle who served as a mentor and math tutor to her on a regular basis. And I think that my uncle, he said this recently, he's like, "I wish you had told me that you were struggling through some of your courses."

Mentorship and support are key ingredients which Dana recognizes as crucial to her own success—as well as her cousin's. Dana recalls "pulling B averages" in her labs, but only C averages at best in many of her core courses in her science based curriculum. She was being

constantly pushed by her peers in her summer bridge program (established for minority students), in which she had found continued mentorship from one of the more senior administrators. She credits this individual to much of her success to this day, and she still keeps in touch with him. Still, this positive mentor was not enough to keep her in the STEM major, however, since this was not a STEM initiative and was not representative of the attitudes she found running throughout her core science coursework.

That's when I started losing faith in myself. After six months into Dana's program, her faith in her own abilities progressively waned. She insists that her instructors were the opposite of helpful, that instead, they seemed to be enjoying the struggle she was having. No matter how much ongoing support she felt within her bridge program, it was still not enough to counteract the reoccurring inadequacies brought on by faculty attitudes—compounded by the cultural isolation within the larger college culture. Dana recalls one particular experience which crushed her spirit and belief that she could one day enjoy a career in a science or medical profession; she credits this moment as the defining point at which she knew the pursuit of a degree in chemistry or biology had come to an end.

> Oh, I remember having an experience, it was kind of a negative surprise. But I remember an experience with my chemistry, this was probably the pivot, when I wanted to try out, I wanted to get some sort of an internship, like a medical internship and you needed a letter of recommendation from a professor and I asked my chemistry professor if he'd write a recommendation for me. And he said he didn't feel comfortable doing so because of my performance in his class and that was, kind of, my moment where I was, like, "Oh, maybe this isn't going to work"…That's when I started losing faith in myself…Again, you're all competing against one another so you're like, "So and so is getting his

internship this summer." And that's what you need to do to build that rapport in your field…but, if I can't even a letter of recommendation from a professor because I can't, like, pull anything higher than Cs in your course, I'm not going to be able to do this. So, he looked me in the face and said that, and I'm just, like, "OK." So, I will not forget that.

You're a weirdo. Dana explained how within STEM she was one of the few Black people, especially Black women, but in other majors such as sociology, history, and communication based majors there was more diversity as a whole. Her initial social circle consisted only of those folks originally in her bridge program, however her interests did not always align with the expectations of the others (mainly Black and Latino) within it. Dana notes how this ran opposite to her childhood experiences, which consisted of high interaction with many White students as well. In addition, her religion was not the same as those attending this faith-based school—only adding to her mounting feelings of extreme isolation. She explains:

They were just like, "You don't like, you don't believe in Jesus, like what's wrong with you?" So, it was just, kind of, like, isolating at the same time and I keep in touch with some of them…I felt more comfortable I think, with a diverse group of friends that included White people, not just all I hung out with was the [bridge program] students that I had met that first term. No, I'm not doing [Gospel choir] and like they wanted me to do all those things that Black people are supposed to do on campus, like, and I was like, I'd never fit into that bubble, I'm never going to. Why would I do that now? And I think that that's when they were, like, "Oh, we don't understand you. I mean, you're a weirdo."

I remember always wishing it was as easy to remember…equations…like Hip Hop. One place, however, where Dana fit right in was with the girls' step team dance group. She explains how they performed between bamboo sticks to the latest Hip Hop songs. "You wanted

to be there…they are welcoming to anyone…All I wanted to do was go to those events and go to those diversity clubs and the [step team] was by far the most fun because they let anybody in." This, however, she explains was one of the few places that Hip Hop culture had any presence on her campus.

When asked directly about her affiliation with Hip Hop she explains how being a visual person she is especially receptive to things she can directly experience.

> If I can touch it and feel it and see it, I remember it…I remember always wishing it was as easy to remember all this crap from pre-med and equations as it is for lyrics to a song like Hip Hop, like some of the catchy 90s Hip Hop that I love so much and would listen to my brother play on his guitar.

Though she explains that the cultures of STEM and the culture of Hip Hop are, "miles apart, like, centuries apart," she suggests that perhaps elements of its relatability should be incorporated into the curriculum somehow. She jokes how till this day she remembers lyrics by a 90s rapper named Skee-lo (to his hit song "I wish"), but that she cannot remember, "what the number 16 is on the periodic table." She expands on this and the unnecessarily stale nature of some STEM courses, while reiterating the theme of intentional trickery evoked by STEM instructors.

> I'm not saying that Skee-lo should teach math or chemistry, to be clear. What I think would be great is if you could make the sciences a bit more relatable and engaging for students, and less intimidating. We know it's serious, but why so stiff? Why can't I ask the instructor a dumb question or I get judged by my question? Why are you trying to trip me up in the exams? I know they are trying to prep you for the "real world" and the "cutthroat culture" of many STEM fields, but is that really their job as instructors? Their job is mastery of learning outcomes first and foremost, so if it's Hip Hop or other

engaging ways to get students to relate to what they are studying and actually have fun in the process, gamification, etcetera, they should be open to all methods.

William's Story

William is originally from the West Coast, and was raised only a couple of blocks down the street from one of the more notorious hot spots for gang activity in his home state. However, William was somewhat sheltered by this reality through his love of music, and by intensely practicing his craft as a musician early as age six. William's parents recognized his talent as a young child and enrolled him in private schools early in grade school. William would continue to play music while focusing on becoming musically proficient, something reinforced by his first professional performances by the age of eleven. He did not attend public school until he was enrolled in a gifted magnet program just prior to middle school. This occurred about the same time he started playing his first professional music gigs, mainly in churches, which also served to continuously insulate him from the ever increasing rise in gang violence in his community.

William would go on to become a respected professional Jazz musician, with an intense love for Hip Hop music and culture. He would also go on to earn his bachelors, masters, and PhD in music; he is currently an associate professor of music at a major East Coast university, as well as an author, active community member, and ordained minister. But it was his math skill which initially landed him in a prestigious West Coast university as an undergraduate student. However, only a handful of credits from earning his degree in mathematics, William left behind his aspiration of becoming a high school math teacher in his home community and chose only to persist towards attainment of his music degree—which he would soon earn. He credits this achievement as a direct result of the mentor he found in his music program. This positive role

model showed him a potential pathway to graduate school and an eventual career; a mentor

within his mathematics degree program never materialized.

As a life-long lover of music, William chronicles the events which led to him becoming a

STEM major in the first place. After only two years of attending public school, and with the rise

in gang-related activity in the public schools, William explains how his parents pulled him back

out after grade six to enroll him in a "fairly ritzy" all boys prep-school. This event directly led to

his interest in a potential STEM career.

> I had to take this, you know, the XXXX, which was the standardized test for fifth and
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> sixth graders to test into seventh grade, independent schools. There I was opened up to a
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> world of privilege that I had never known or seen before, not only in terms of curricula,
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> but in terms of the accouterments of school, I mean we had a phenomenal track, had a
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> killer football field with bleachers, it had an Olympic-size swimming pool, it had a
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> fencing team. I mean, just stuff that I had never even knew existed. And they had a
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> synthesizer lab, so I was down there making beats, and making music. The way that leads
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> to my decision to STEM is, I had always been gifted in math and science, just, not only
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> via interest, but the stuff came easy to me, you know? Not only through, you know,
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> geometry, pre-algebra and algebra, trigonometry, all that stuff, but even calculus.

It was this talent for mathematics, which encouraged William to major in math as an

undergraduate. He would develop his own confidence in his abilities in high school, and his

competitive nature would eventually fuel his desire to succeed—amidst doubt by one less than

impressed instructor.

You'll never get this; you'll never succeed in calculus. In his senior year of high

school, William took calculus A/B, taught by a very young instructor who had gone to a very

prestigious West Coast university and also excelled at mathematics. William was able to pass fairly easily, without appearing to break much of a sweat, and without high assistance from his instructor with whom he found little favor. Between his junior and senior year in high school, his academically mindful parents had helped him enroll in calculus at a junior college to be more prepared while potentially earning college credits during the process. William, however, recognizes his own immaturity at the time, and how his natural ability, infuriated his teacher. He narrates how his overall fascination with mathematics fueled his extra preparation to pass his upcoming advanced placement calculus test, and how this enabled him to skip out on a class taught by a less than favorable instructor.

> I was pretty rambunctious, a little bit arrogant—and, I cut class a lot, but I would always show up when it was time to do quizzes and tests, and I would always turn my homework in via a peer. I'd be down at the synthesizer lab making music. So, one day, and I was rocking a steady B; I had a steady B in the class, you know? So one day, we were handing in an exam, and he got really pissed [he did well on this test without attending] and said, "You know, you'll never get this; you'll never succeed in calculus." And, so, for me, it became a challenge.

This "challenge" resulted in a life changing moment of clarity for William. He now had his sights set on proving his doubting instructor wrong. His intention was now to attend the rival school of his math instructor and get a math degree.

The cultural disconnect William had with this teacher fortunately did not become an insurmountable obstacle resulting in a lack of desire to excel in college—like it so often does for countless others. William faced with a "fight-or- flight" moment chose "fight" and set out on a course to earn a math degree despite negative sentiments from his teacher. But once in college, a

similar disconnect would curtail his desire to attain a degree in mathematics and William would instead earn a music degree with the support of more caring instructors, students, and mentors.

This singular focus of proving his teacher wrong became an obsession for William and drove him towards his goal of becoming a degree holder in mathematics and a local high school teacher in the community. Being told he wasn't good enough to succeed in such a historically "hard" discipline as the mathematics of calculus was the kind of doubt he needed to prove others wrong. William already possessed a Hip Hop swagger which allowed him to be reassured that he could succeed at anything he put his mind to, so having this "hater" faculty member in high school for a teacher gave him all the drive he would need.

> He went to XXXXX [rival institution]. You know...the enemy archrival of XXXXX is XXXXX, though, so I set my sights on getting into XXXXX. He was a math major at XXXXX, so, already I decided I was going to major in math at XXXXX and I was going to get my math degree, come back down to the high school, put the math degree on the table on his desk, flip him the bird, and walk off and go on and live my life. I mean, that was, that was my mission, you know? And so, I did get into XXXXX…I did major in math.

I met a music professor who, who literally changed my life. An unexpected turn of events while in college led William back to music. William would meet one music professor who became his mentor. This altered the course of William's entire life. Ultimately, it was a lack of support from a math teacher which brought William to STEM, and it was support from a music teacher which ultimately pulled him away from STEM and led to his persistence in music.

> Somewhere around the second semester of my freshman year, I met a music professor who, who literally changed my life and, and shared with me about how passionate he saw

me about music, and that became one of about three different ways that I made my

transition to double-majoring in math and music. And then I finished my, my music

curricula, at the end of my four years and decided that I was going to go and just graduate

and not come back for an additional semester. So, that's my escape from STEM, as it

were, into the creative arts into music, as it were. But I had got pretty much through the

curriculum, I had about three or four courses left in my math curriculum to finish my

math degree.

Clearly, this relationship eventually brought about the onset of William's attrition from his

STEM major—but it was not immediate. The process of falling out of love with mathematics as

a degree choice and back into love with music may not have needed to occur as discrete events

had a better overall STEM experience occurred for William as an undergraduate. The same

mentorship he found as a music major had not been as readily available to him as a math

major—something William directly attributes to his race.

There were six of us African Americans who were math majors. A steady and

systematic decline of Black faces during William's college career may be pinpointed to specific

legislation. This occurred at a time when the city school district realized it needed to enact

relatively costly measures to attract scarce Black faces to teach in the classroom. William would

experience first-hand how this "pipeline" was being systematically shut closed at the valve,

making finding recruits of color to come back and teach math in the city analogous to finding

another of Dana's mythical *unicorns*.

When I got there, I didn't think it was that diverse but, the year that I graduated, which

would have been at 1996 was the year that [legislation] passed…which got rid of

affirmative action. So, and the reason I say it's relative is because my four years at

XXXXX were the last four years of there being, maybe, an eight to ten percent

population of African Americans on the campus. The following year was one to

two percent and I think it still flat-lines around three or four. Matter of fact, that year, '96,

one of my classmates was the only Black person accepted into XXXX Law School,

which was XXXXX's [his institution's] law school, which was from, like, fifteen the year

before. So, they got rid of all – but, on the other hand, it was, there was a huge

populations of Asians, particularly, Korean, Chinese, Japanese and Indonesian. And these

were the individuals who were in my math classes with me.

William goes on to recount specifics in terms of numbers of Black math majors on campus with

him. He recalls, "Within STEM, in my class, entering class of 1992, there were six of us African

Americans who were math majors, and there were two African American females in the whole

class of maybe 300, 400." He clarifies that the numbers may be even worse, as visually he could

see within the foundational math course lecture hall classes that only a handful of Black faces

were visible among the hundreds of math majors in the classroom.

William continues by explaining how surviving as an extremely small minority group in

a relatively difficult major was particularly challenging, especially when other racial and ethnic

groups were regularly forming study and support groups along these clearly visible qualifying

identifiers. His own arrogance was perhaps the one thing that could again save him. He simply

believed he would achieve no matter the odds. As time went on, William acutely became aware

that he was being set up to fail, and that the metaphor of "us vs. them" was being tacitly

understood by all stakeholders. He compares the entire college experience in a STEM major to

that of a battlefield, where he and his small and dwindling cohort of Black males were—*at war*.

Well, I mean, I was jaded because I was, I wasn't coming for altruistic reasons. I was coming to stick it to this dude. So, my M.O. [modus operandi] was to just get this degree. So I had no kind of concept of what I was getting into, other than the fact that a little bit of arrogance helped me to think whatever I was going to meet, I was going to conquer it and keep moving on. So, when I showed up to my first class with, like, 300 people in it, and some dude who really didn't speak good English, he was a TA down at the bottom of the amphitheater just drawing stuff or talking with his back towards us, and I was blown away because I had gone to a private prep school with small classrooms with very interactive teachers who will spend extra time with you during lunch, or whatnot. And here is this dude who really wasn't even the professor. He was a TA who could care less whether you got it or not. So, it created this need for some kind of support group which made the whole study group thing a bit, you know of a quandary. But then it did bridge those of us who were African American to actually study together and seek help together. So, it was kind of a unifying factor and we was kind of at war. You know, in war you match up with the people who are the same size, same speed, you know, same M.O. as you. So, it kind of created that sense as well.

With very little support from faculty, in particular seemingly very apathetic teaching assistants, student peer groups could make or break the success of members within each particular subdivision. So while "diversity" was very apparent on William's campus, it seemed that all of these diverse subgroups were well represented and supported, except for those representing the African American population. This created stigmatizing inadequacy which could be directly communicated and felt by William and his cohort as math majors trying to survive against the odds and less than ideal conditions.

The reason why, the challenge was study groups. And so the majority of the Asian population, whether Korean, Chinese, Japanese, Indonesian, and even Southeast Asia, Indian, would have these enclaves based on ethnicity and race. And even if you were, had lunch with one of them, or whatnot, when it came to the study group, you were not invited. And should you penetrate the study group, then one of the defense mechanisms that they used was using their mother tongue.

You got to be twice as better than your competitor. Not only does William express a lack of necessary support from the faculty and staff, but the students within the major also seemed to be culturally at odds with him and his small cohort of African American math majors. While this was certainly unwelcoming and isolating, it did however create a tight-knit group of students all working to survive in a difficult major. William explains the nuances he felt being the more marginalized "other" within the major.

So, all of a sudden, you'd be in his group and then all the Korean students would start talking Korean and laughing and, you were clearly, it was made known that you weren't supposed to be there. So, that left a lot of us, particularly the African Americans, to try to figure out how to create our own study groups because we weren't competing at the same level as they were.

William would later come to the realization that the Asian students, despite the rumors he had heard of their superior math ability, would also struggle to persist and earn respectable grades. William explains how he had always been pushed to excel with the need to be much better than his non-Black counterparts—but without cutting corners, and by earning the grades fair and honestly.

You know, the funny thing was, and this is cultural, in an African American community, at least in my family, there was always this thing that, because you're a Black male, you got to be twice as better than your competitor whether White or whether whatever. But, then there was this other thing that we had a sense of integrity where being twice as better didn't mean that you cheated or that you would try to get the upper hand some way. We found out that a lot of the Asian students were reprogramming their scientific calculators and were creating, I mean, using technology to create opportunities to cheat and, man, that baffled me. You know what I mean? Because you, because we were always, kind of, culturally taught that the reason why the Koreans or the Chinese or Japanese or Indonesian or whatever were more successful is because they put more sweat-equity into study that they spent more time to be here.

This left William and his small cohort very upset and unsure of their future. He explains how this baffling experience brought about a realization that they could keep pace, but, without cheating and without more supports in place, it would eventually become even more difficult to persist and succeed without more unity amongst themselves. He recalls the emotion of the situation and the consequences going forward.

I think once we got over the fact of being pissed you know what I mean, because we're struggling, you know what I mean, to keep up, in not necessarily the first year, but by the second year by the time we get to some of that linear algebra, whatever it is, second year, dude we're struggling. Now you've done run out of the calculus, you went to the other stuff and we don't have access to them, so, once we got done being pissed, it just made us gel even tighter.

These experiences led to William becoming a sophomore with some serious decisions to make. Which branch of mathematics would he major in, and how would he find time to proceed academically and socially once the basic coursework common to both disciplines was quickly coming to an end?

> That's around the time at XXXXX, at least, where you decide whether you're going to do pure math or applied math or if you're going to transfer to the Engineering School. So, some of the math [majors] maybe decide to go mechanical. Most of them with mechanical engineering during that time. And so now they were gone because now they're over at the Engineering School and they got different, you know, curricular assistance, or whatnot. So our group grew smaller and then here's around the time, also, where somebody didn't pass a class and couldn't get the prerequisites to go to the next level with the rest of us, so now we become fractured.

The problems associated with this shrinking math peer group became exacerbated for William due the fact that he was already functioning within two majors, while splitting his time with folks in each major. William also recounts how he continued playing gigs through his free time around lunch or on certain evenings. For a variety of reasons, William found it challenging to spend as much time socially connecting with the other math majors as he would have preferred. He explains how all of this, along with the normal demands of being a math major, served to undermine his intentions to persist in mathematics.

> Yeah, so now really pissed because now your group is smaller and you don't have the firepower and then, by the time junior year came, now I'm fully entwined into music stuff, so I'm only taking a few math classes, so even I fall behind of the major curriculum, so it becomes this thing where everybody ends up on their own, which pisses you off

even more because you don't have a cluster to compete with those other groups that you

see who arrived and grew as a cohort.

When forced to make a decision of one major over the other, William ultimately decides to

persist with music where support was more bountiful than within the culture of STEM at his

institution.

There was nobody to say...you guys are talented, you guys are gifted. William

explains he fully intended to graduate with a double major after taking on the music major as

well, but it became apparent about halfway through his curriculum in both majors that this was

becoming increasingly difficult. He explains there were simply not enough elective spots left at

the right times to fulfill all of the requirements of both majors, "If you don't fulfill one

requirement or prerequisite, then you have to wait a whole 'nother cycle in order to get that next

class. There just wasn't that flexibility to be able to do both at the same time." Further, the value

of a math degree was brought into question, especially when considering the enormous time

requirement to complete many challenging math assignments.

> With the exception of knowing that I was going to go back to XXXXX and be a high
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> school math teacher, as I began to overhear some of my other competitors' ideas about,
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> you know, going into statistics or going into quantitative analysis or going into, what we
>
> now call, as big data. I didn't know anything. So, for me, the math degree was a pathway
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> towards being a math teacher. At a certain point, I was like, "Dude, why do I need to
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> know all of this in order to go back to teach pre-algebra?" You know what I mean? I'm
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> doing a problem set, or, at a certain point, I'm doing one problem that's going to take me
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> two to three weeks to nail in order to go back to XXXXX and teach pre-algebra. Are you
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> kidding me? So, I didn't see the ROI [return on investment], I didn't see the return on the

investment here, so that became something that was very disappointing, man, very disappointing.

Compounding this problem was the reality that in music he had found a mentor, who was now also advising him on continuing his studies at the graduate level, and in math no such person existed. Also, the discipline of mathematics was devoid of the types of diversity William was accustomed to having present. William further explains his second thoughts regarding the financial considerations of holding a math degree versus earning an undergraduate degree in music and going to graduate school—as well as the lack of mentorship and diversity in the STEM major.

Yeah, so I'm like did I make a mistake? And I think part of that is it would help me to do the music thing because I knew that at least I can go to Graduate School and, plus, the final thing for me is that the same way I had this professor on the music side I did not have a professor on the math side. I did not have a mentor on the math side who was able to give me access to opportunities or show me things that I had never seen...So, forget about having a professor of color or having a female processor. You could forget both of those, but there was nobody in the math department who took an interest, a vested interest, in me or in our group to say "You guys are talented, you guys are gifted. There's some opportunities here. Let me introduce to you some." So, I had that on the music side.

What are you all doing here? You all got the wrong major. William also perceived the overtones of systemic racism playing a role in keeping mentors from emerging. William reveals how he was acutely aware of the feeling in the air that folks from within the department believed he and his Black cohort did not really belong and were somehow discrediting the major due to their Hip Hop swagger and dress code—which was anything but the "geek" stereotype.

In STEM, I saw racism, in my opinion, at its most glaring and most spectacular, you know because, again, the reason I keep saying "us" is because I would articulate that we were forced to jail because there was no other system for us to be able to make it through …So, the racism plays in because, as you look for mentors, as you look for individuals who will take an interest in you, not only did they not exist in our, in our hue, in our ethnicity, in our color, but it seemed that everybody else had some of kind of leg up whether culturally, ethnically, or whatnot and it seemed like we were just the experiments.

Within William's music major, however, there was a bit more diversity and a stronger congenial attitude from students outside of his race or cultural background than from those within his STEM major. It was generally a warmer and more welcoming environment across the board, with more student and faculty assistance.

The cultural improvement William experienced within his music studies, as opposed to mathematics, he attributes to the more overtly obvious nature of a person's musical talent compared to mathematics. William explains this in detail.

Music was much more nurturing…I think music, you have a, more external, externally visible talent than you do in math unless somebody is reading your problem sets and stuff like that. They don't really see how gifted you are, but music, it's an externally pushed thing, so I think my talent was unique enough to the point where people actually wanted to put their hands on it.

Yet within the realm of the mathematics major he could not help the feeling of being an experiment, due to clearly racially motivated doubts concerning the ability of these young, Black, Hip Hop students to do the necessary work. The climate was hostile.

We were the guinea pigs to see if Black males at this point, it's junior year, if Black males can actually do this stuff and we felt like that…yeah, we were adamant about expressing it, which made us a little bit more political and antagonistic, you know, because, at a certain point when you deal with these Nobel Peace Prize-winning professors who don't give a rat's ass about you because…you're just somebody who's taking up a space…so, we was like, there was no respect. There was a sense that we didn't belong there, but they couldn't throw us out because we were making grades and then there was also the sense that we were culturally diminishing the respectability of the department. You know, because we'd come in with our jeans and our Jordans on, we go to class and then go play ball and then go back to study hall, or whatnot. So we didn't look the, you know, the nerdy geek…we had our own swag.

The clear difference between feeling welcomed into the culture of the music department versus feeling the hostile racial attitudes of faculty, staff, and students, who seemed to be wondering what these Black folks were doing majoring in math, could not be more at odds. William recalls, "I think race was an unspoken element that was always in the room and there was a deterrent in many ways because you could see the disparity between how different folks were treated. The fact that you didn't have any leadership that was representative of being a Black male or even a Brown male in the [math] department was a deterrent."

A reoccurring theme throughout Hip Hop culture is the idea of making something out of nothing and succeeding despite the odds or a lack of resources—while proudly doing it differently and boldly. In some contexts, many would refer to this characteristic as "grit." William expands on the idea of not looking like the typical math student, and succeeding despite thoughts to the contrary by naysayers.

You got to be smart enough to actually get into school and do well, so all of that nerdy

stuff, that phenotype of, of what a nerd looks like, that was broken from day 1 because, I

mean, some of us, we may have come from the inner city, but for whatever reasons or

not, we had the academic acumen to, actually, succeed at the school which everybody

who was in that program with me succeeded in some way, shape or form, so there was

this, kind of, sense, of you know, "What are you all doing here? You all got the wrong

major?" We're going to let you all know that you don't really belong here. "Oh, but

they're still here?" So let them know that they really don't belong. "Oh, you guys are still

holding on? How cute."

Outside of a Black engineering student organization, William recalls little support dedicated to

ensuring students like him persisted through STEM disciplines. However, a summer bridge

program was in place entering his freshman year, and for whatever reason, William recalls black

and brown faces among the faculty—something distinctly different once the actual academic

school year would be underway. Still, one consistent presence on campus that was supportive of

his culture, however, was the culture of Hip Hop.

Hip Hop has always been the tool that I have used…in order to memorize. William

joined Alpha Phi Alpha, a Black fraternity, in college. Within this fraternity Hip Hop was always

prevalent. In addition, the university ran a radio show that also had regularly scheduled Hip Hop

shows. The importance of this for William cannot be understated. Even within William's

inclusive music program, he was the only Black music major his year to graduate. Though the

culture of music may have been far more welcoming than STEM, the familiarity and shared

common identity with those who have lived Hip Hop culture creates a bond on an entirely

different level. He recalls the impact Hip Hop made on him since as early as he can remember.

I remember when I was about 4 or 5 years old, when *Rappers Delight* came upon the radio, man. XXXXX on the AM dial, man. Oh, I remember that, I remember the way that it [Hip Hop] helped to galvanize young people to feel empowered to speak truth. And so I remember on Fridays, in elementary school and then later in junior high school on Friday evenings, we would beg our parents to stay up because XXXXX who was the DJ on XXXXX will play an entire album. He would play whosevers' new album was coming up that week. He played the entire album and we would sit there and try to transcribe those lyrics on the first listen. Then on Monday, those of us who had transcribed a good piece of it, we would have memorized those lyrics on Saturday and on Monday, right there at lunch time. We didn't try it at recess, but at lunchtime, we would gather in our cypher we would see who was able to spit the entire lyric.

Hip Hop music and culture continued to provide William with a shield from the negativity and violence in the community as he grew up. He explains how the common thread of understanding and being "down" with Hip Hop culture was the only commonality that mattered, which he shared with the multiple gang sets in the area.

So, by us unifying ourselves around this Hip Hop culture, when the gangbangers came, we actually stood our ground because we were all from different neighborhoods and so we didn't represent a set but we understood that the gangbangers were anti-whatever we were doing. So Hip Hop culture gave us a sense of empowerment.

Perhaps it is no wonder then, William would feel immediately connected with those who were clearly a part of Hip Hop culture on campus; this in itself was an aide in persisting, despite less-than-hospitable cultural norms throughout the STEM community and a lack of Black faces

across both of his majors. Further, by incorporating similar techniques to those used when memorizing Hip Hop lyrics, William helped to ensure his own academic success as well.

> I've always created rhymes to memorize stuff. You know what I mean? So even in a practice sense, Hip Hop has always been the tool that I have used in terms of the musical aspect of it to associate with other things in order to memorize, you know, whatever it is. So I'll create a rhyme and memorize my states and capitals as a kid, or I create a rhyme to memorize my multiplication timetables or my multiplication facts. Or I even create a rhyme, I forget how it goes, to even do the quadratic equation, I mean, you know, how to flow it, you know?

When asked specifically about how William feels STEM and Hip Hop are connected, if at all, he becomes very animated due to his obvious passion about the subject of the question. "I think they're very similar. I think for me and my experience, man that grassroots, you know what I mean?" William makes it more current, and explains how he reiterates this sentiment now as the instructor in his own classroom. He reminds his students of the intimate connection between mathematics and music, while yearning to make personal connections with his students as well.

> Then the other thing is…the first day of school no matter what class I'm teaching, I always shared that was I double-major in school and that I was a math major because I think still African Americans and Latinos are underrepresented in the access point, right? To show that, wow, there's a Black dude. He is a music professor now, "But that dude majored in math, right?" And then to also make the point that there's an inextricably power link between math and music…the way that I process when I'm doing improvisation, is all mathematics. Now, it's touch, feel, it's emotional, and it's based on how I'm feeling. But you have a certain number of notes in a scale and there are

permutations and computations in terms of how you create your patterns and so, whether we conceive it or not, that's a mathematical exercise and that's kind of how I, how I look at it. So, when I'm home practicing and thinking up new riffs and thinking up new stuff, it becomes also a mathematical exchange, too…a major third, minor third, you know, half-step, whole step and how did you create these new skills of half-step, whole steps and how do you permutate that when you do all over 12 keys and, so, they're very connected. You know what I mean? So it's funny when you have creative people who said they don't do math or they don't science, I'm like, "dude how do you explain your creativity?" Because the only way I could analyze it is to do math.

William also reflected on his own success as a college student and the role Hip Hop has played along the way. He elaborated on the role Hip Hop has played, and continues to play, for countless others as well. However, William's responses to these types of questions concerning the importance of Hip Hop culture and its potential role within STEM were so rich, that perhaps it was the reason the final interview question on the role of Hip Hop culture in STEM or the campus culture as a whole was never posed directly to him. Nonetheless, after this interviewer's request, William answered this final question in writing so that it could be potentially included. The following is the reply William provided in its entirety.

The elements of Hip Hop culture offer a unique approach to articulating the essence of life. There is the heartbeat (the musical backdrop) from the DJ, there is the personal narrative and opportunity to express one's needs, desires, concerns, etc. via the MC. There is the self-oriented communal expression through dancing (where the individual brings their individual swag to the communal space). Then there's the personal aesthetic that joins together to formulate a cultural aesthetic (like-minded people connecting

through their individual and unique perspectives) via fashion, language, entrepreneurship, etc. Hip Hop culture was one of the first times in the history of the US (and perhaps the world) when young people (teens and young adults) disrupted the social order and social hierarchy in order to empower their own perspectives, views, opinions and creativity. It is this disruption of innovation that has led to scientific discovery and all kinds of new creations in the areas of STEM. It is young people and their courage to think beyond the boundaries and to do it loud and proud that lead to new discoveries and developments in science, technology, engineering and math…and much of this discovery occurs outside of the academe and outside of the classroom. Napster was created in the dorm room as was Facebook. These were created by young college students who were not content with the status quo…or content with "staying in their place" and "waiting their turn." In our STEM classrooms we need to use the spirit of Hip hop to inspire, creativity, out-of-the-box-thinking and an inquisitive spirit that is unquenchable. We need to inspire the next generation to think of more questions and not try to have an answer for everything. Campuses should stimulate exploration and search for the unknown rather than hiding the unknown behind the "we've always done it this way." Innovation is stimulating, attractive and intoxicating…and it is this approach that will lead to more excitement, more enrollment and more participation in the STEM areas.

Antonio's Story

Antonio is no stranger to culture shock. As a resident of the inner city of Boston (Roxbury), he explains that academics were "different" and not treated with the same importance as he saw elsewhere during his educational experiences. He had the good fortune however to attend a college preparatory middle school in Boston, which he states was the first place he ever

felt academically challenged. Antonio would next become fortunate enough to attend a private boarding school for his freshman and sophomore years, where goals centered on constant academic excellence for virtually all of the 300 students. Antonio, however, was one of very few African American faces that could be found anywhere at this prestigious school. Drastic changes of scenery and culture were simply an early part of his educational history which would continue throughout his entire collegiate experience as well.

No longer in college, Antonio has attended four different higher educational institutions for nearly seven years. He currently has no degree to show for it, but he hungers for knowledge and is a deep thinker. He is still searching for a path to completing a degree in STEM, mainly due to his love for challenging his own limitations and a fondness for the scientific method. He watches, the wildly popular, *Crash Course Astronomy* with Bill Plate regularly on YouTube. He started college in a biology track, thinking he wanted to perhaps investigate the mind or the reasons people make the decisions they do. With an interest in physical therapy and the science behind the body's mechanics, he adapted his original degree choice of biology-meets-sociology-psychology into kinesiology. He continued completing the core STEM coursework he would need along the way, and was enticed to design his own particular course of studies in educational technology—as a more practical and financially rewarding career choice when finances were no longer a given.

So far for Antonio, a degree in any of these areas has not yet been earned due to various obstacles, including culture clashes and racial insensitiveness, the need to work, and a general lack of ability to relate with the standard provided help. However, Antonio did go on to become certified in massage therapy. Still, he wishes to earn a four-year STEM degree and cites programs at UMass-Boston as a possibility, perhaps with a concentration in exercise science.

What follows is an in-depth narrative account of the many intricacies which have kept Antonio away from realizing his dream of degree attainment in a STEM discipline.

I think it's more that I struggled that I gained an appreciation for it. Before college, Antonio's academic experiences were not always that the curriculum was consistent from one school to another; sometimes it was a "cake walk" or other times it was difficult to keep up. He explains how once at his private high school he found it a bit more challenging and fell off of his own expectations. He was a strong math and science student in middle school but had a few bumps in the road during his freshman and sophomore years of high school.

Antonio recalls how easily it had all been for him up until this point, "I did well in math classes there [preparatory middle school] and in science, and it was always a comfy, comfy field, and I felt pretty good in all of my abilities there." He describes his first memory of taking courses in grade school containing STEM concepts, and how he potentially became interested in them due to the challenge.

> I don't think my aspirations or, you know, kind of the origin of my interests were as, as deep as they are now. I think I had natural ability for these subjects at least by Boston Public School standards. Grade school, middle school, I achieved almost effortlessly and it was just reassuring to do those things that, kind of, came easily as it was when I started to have trouble with some of these concepts and maybe received a little bit of tutoring.

The fact that Antonio had experiences inside and outside of Boston Public Schools as a child allowed him to see that all school systems were not created equal, and that he had essentially been a "big fish in a small pond."

Antonio displays an awareness that perhaps the challenges he met at other schools were not entirely based on his own doing. He realizes he may have been overconfident due to being

underprepared by the schools he had attended, which also may not have been accustomed to providing challenges for a person like Antonio who was learning the material almost effortlessly.

Then I thought, you know, it sucks that I'm not getting it as quickly, but, the fact that you can, you know it's kind of rudimentary, but like algebra concepts…basic things like that are just so simple, so straightforward, it has a warming aspect to it, you know? But I think it's more that I struggled that I grew an appreciation for it, but it's always just the way the system worked didn't glide right for me, you know?

At his new private high school, Antonio always felt as if his lower grades were not an accurate representation of what he could do in a different setting. This school was nearly twenty-five miles from home (a 40 minute drive, or an hour and a half by train), and his immersion into a totally unfamiliar culture at such a young age was perhaps a bit much to manage. Antonio elaborates on how his passion for STEM based topics had not dwindled despite some of these new obstacles.

I still had an interest especially with subjects like algebra and beyond. Just how these concepts have, you know, come to be. The people, how they just appeared to certain mathematicians or scientists. I've always found that intriguing, but the work was just so demanding that it was, it was kind of hard to carry that passion into the workload…I wouldn't say my interest started to dwindle but my, my confidence in my ability…

Perhaps a positive result of the difficulty he faced at his private boarding school was that the school had him tested for a potential learning disability. Had Antonio not experienced some degree of confidence before this, perhaps he would not have been as willing to receive this form of potential "help." Antonio recounts the first documentation of his learning disability.

I got tested for attention deficit disorder, I think its ADHD. Across the board now we

were calling it ADD, and that got me, that qualified me for help from disability services

in high school. So, that's where I would go, mostly with my trouble and they were

accessible and they were helpful to a degree.

The help he would receive in smaller settings with individual attention is something that Antonio

would come to expect at his next level of education, but he was not always willing or able to get

this same form of help from all of his schools—or his immediate family.

In terms of getting my homework done, I wasn't looking towards family at all.

Antonio would transfer to a small urban high school in the heart of Boston, where he explains

academics were not being treated as much of a priority by the faculty and students alike.

However, Antonio's strong preparatory background placed him in good enough steed to still be

able to finish and be accepted into a first year college program in the heart of his own city. Both

of his parents hold masters degrees and are active in education. However, it is clear his

relationship with his father has been especially strained. Unfortunately, Antonio has not been

able to embrace the full potential of his parents' vast educational experiences and cultural capital

gained while navigating academe. He explains the situation in a bit more detail.

My father and I don't speak so much, but I know he teaches other kind of studies at

XXXXX, and my mom, something along the lines of education, maybe sociology. I know

she was doing family work for outreach for a long time.

His parents' value of education, however, allowed him to have opportunities to attend

institutions that many others have not been as fortunate to receive. Still, Antonio would often

turn outward from the family for help academically. Antonio continues, by explaining his take on

the complex relationship and support structure that has undergirded his own academic experiences to this point in his life.

> I wouldn't say that they were, for lack of a better term or set of words, I wouldn't say they were that collegiate, besides my father. I don't talk to him so much, so that discounts him, but my mom, necessarily, wasn't a collegiate type. I feel that I can write better than her. She will, anything mathematic, she'd rather kind of delegate to me. So, in terms of getting my homework done, I wasn't looking towards family at all. In terms of getting through college, they were supportive, but there were times when I would stress, where it didn't really seem it was, like, going to college at that time wasn't that necessary and that much stress wasn't worth it. So more supportive, kind of finishing my college career came from friends and that's how it worked.

Despite various challenges, including attending a less than ideal high school for his last two years of high school—which Antonio summarizes by saying, "their goal isn't to make you, you know, the most academically savvy person," he would still find success during his freshman year of college.

    A bit of a cultural shock. Antonio was accepted into college at Northeastern University, via Foundation Year, a first year program housed in the College of Professional Studies. This program enrolls only students from Boston, or those who attended Boston Public Schools, into a highly structured and supportive cohort model. This kind of program with built in support structures was clearly attractive for someone like Antonio who was already relying on support from outside of the family—more than within it. Once enrolled in this institution, however, Antonio quickly perceived of the cultural divide in terms of the stark differences between his former high school of the last two years and this exclusive research university.

Outside of the small cohort of Foundation Year students and a couple of other programs, Antonio found Northeastern seemingly devoid of anywhere close to the same high percentages of people of color within its walls compared to his own community just outside of them. As a native of the inner city of Boston, specifically Roxbury, he literally could walk to Northeastern's main campus every morning to attend his classes. But once he would walk through the tunnel of the Ruggles commuter rail and public transit station in the heart of Roxbury, the multitude of black and brown faces would become far scarcer on the other side of the tunnel stairs where the campus begins as soon as students walk out the door. Antonio details some of this cultural divide, as well as how it led to him considering a major in sociology or psychology.

> I went to [private high school] for, for two years my freshman and sophomore year there was a big, a big change. A bit of a cultural shock, as some would say. I come from Roxbury and academics are different; population was clearly different, and you know, I just, kind of, hold in my mind what could I have done better, you know what exactly was different. So I was in between social, sociology and psychology, but that's what I was going for, so when they offered their biology track and in Foundation Year, I knew I was going to take that, in whatever institution I ended up at. I was going to go ahead and continue doing that and I think it was mostly just, kind of going through that, and just seeing the difference in between cultures got me really thinking, like "How do peoples' minds work in any given environment?"

Antonio took courses under the guises of this *biology track*, in which his elective credits were geared for someone who intended to major in the sciences. He explains his selections.

> I felt like biology was going to be definitely required for either [major], so I thought I would just get that out the way and it went over okay. I think they split it up into Biology

1 and 2, and Biology 1 was not too difficult. I do think my high school experience

adequately prepared me for that.

Antonio would do well enough in Foundation Year to transfer the following year from

Northeastern to UMass-Amherst, with a good deal of the tuition paid for by partial academic

scholarship money after completing a solid freshman year. However, the individual attention at

his next institution was not a given, and after a year of intense support (whether students were

looking for it or not), another contrast in cultures was yet again waiting for Antonio.

Where's my time? At UMass he would be accepted into two major programs—

psychology and kinesiology. He explains his choice of his decision to try and double major at

this point.

Psychology and kinesiology are both subjects that you know grab my interest. I played

sports through much of grade school and it made sense, and I also think my ego was still

intact from like elementary and middle school of thinking, you know, school has been a

breeze, maybe I can, you know, handle this workload again. So, I decided to try and go

for the double major.

He would go on to complete two academic years at this enormous institution, and would then

again transfer out, just short of enough credits to technically be deemed a junior.

His academic performance at UMass was satisfactory, but he realizes it may have been

enhanced had he taken better advantage of some of the supports they had available on campus if

students sought it out. Antonio recalls feeling a bit lost in the shuffle of navigating such a

massive campus with scores of students all looking for some kinds of supports. He reveals that

though some help was available for his challenging STEM coursework, it was not something he

was always comfortable receiving in such a large setting, especially since one-on-one help was

far easier to receive at many of his smaller schools and programs he had attended up until this point.

> The school was huge, but they did have, you know, a teaching assistant was available, and was from the professor available, however while I was at [private high school]…help from disability services in high school...that's where I would go, mostly with my trouble and they were accessible and they were helpful to a degree. In terms of STEM, I think it was harder to get help within, maybe if it was, like something with writing. There are a lot more staff members who can help out with that, but not so much for mathematics, chemistries, and other sciences.

Antonio felt that, even with tutoring services that were offered, it was always a scramble for time. He also expressed the overcrowded nature at such a large university, which forced students to be mentally and physically out of their comfort zones when seeking out the adequate help they truly needed. He recollects, "Even if tutoring was offered…there are so many people there. I said where's my time? It seems like a barrier to getting the help you needed...to get comfortable"

Antonio clarifies that by "comfortable" he is speaking of asking for help from people he doesn't know that well, where he is also one of very few people of color within his courses or help centers. According to Antonio, a general lack of diversity was clearly an issue on campus. He is quick to point out, however, that with this institution having such a large student body, certain Black and Brown based student organizations and support groups were bound to maintain a good deal of representation of people of color on campus if one sought them out. However, he characterizes the school as "not very culturally diverse" as a whole, with the campus being "predominantly White"—and "to a greater extent than the general population of the country" in most of its larger cities and towns. This made his decision to return home after two years a bit

easier, especially after a first year of attending a college program within an enclave of diversity located right in his own backyard. By this point, Antonio had figured out what was working for him best, as well as the pros and cons of each type of institution. Other issues would also help to force his hand.

Antonio explains his eventual return to Roxbury, where he would next attend Roxbury Community College (RCC), while earning credits towards a technology based STEM degree— something he had not originally intended.

> Well, the reason I chose to go to RCC was because it was close to home and my mom
> had recently fell ill so I had to help take care of her, you know, be close by. But I also
> wanted to get college credits and keep it moving along, so that's why I chose RCC."

At RCC, classes were once again in stark contrast with those from the last institution he had just attended. The overwhelming majority of students in Antonio's STEM based courses at RCC were now Black and Latino. His familiarity with this population, mainly emanating from his own community, was more what he had expected. However, he found that the level of academic seriousness of many students was far lower than his own. He surmised many were still unsure of their own futures and were additionally distracted by being right in the middle of their own city.

> To be completely honest, it was, I hate to use words like sophisticated but it wasn't as
> serious for sure. The teachers were into what they were teaching. I do think the resources
> could be found if you're looking for them, but in terms of the student body, I don't think
> the students were as self-motivated…I think the groundwork to start from, I liked it a lot
> when I was taking, I think I started with pre-calc. We were doing some trig work, so just
> reviewing algebra doing trig, before I had stopped going to RCC. And I didn't know what
> I was, but I was still ahead of a lot of students. The teacher who is just, kind of like, "You

> guys let me answer the questions before. Good, I disagree with you." If you brought out
>
> answers, you know? I left because it didn't feel serious enough.

Though more individual attention from instructors was now possible, the vast variety of courses

to choose from at a major university like UMass was lacking at RCC; this was now another

significant trade-off. When paired with the issue of perceived less-than-seriousness, Antonio felt

it was time for a change yet again. He had originally planned to pick up his associate degree at

RCC along the way towards a four-year STEM degree, but he left prior to being able to actualize

this goal as well.

This began the process of Antonio starting to become interested in a computer science

based degree, after choosing a few such courses at RCC which would satisfy some of his general

STEM based requirements, which he hadn't quite finished at UMass.

> I did want to still be in school and pushing, you know, my degree along, but I think my
>
> intention there [RCC] was to look more into computer science and I thought that network
>
> administration would be like a soft place to start.

However, the overall lack of course flexibility and less than perfect academic experiences left

Antonio researching for opportunities to go elsewhere—and perhaps an opportunity to pursue

something more technologically grounded—and with more support. Though he felt like "a

number" at UMass, he could at least occasionally go to a help center or attempt to find a teaching

assistant or an occasional professor to help. This was something he started doing in the small

private high school he attended, where he also received help for the first time for a documented

learning disability. The larger problem was once in college he did not find the help he needed in

many of the core math, science, and other technical courses, especially during his time at either

of his last two higher education institutions—and certainly not from people he could relate with or with whom he shared many similar interests.

I felt there was a difference between me and the other classmates. The realization of the need to find a tangible, in-demand, STEM career choice via a relevant course of study led Antonio to Hampshire College, also back in Amherst, Massachusetts. He explains the appeal of the institution, "They, kind of, let you pick your own field of study. They'll, like, propose that when you apply, and what I proposed was educational technology." This began an exciting, concrete, and potentially rewarding, STEM based degree program and an eventual career choice.

Hampshire College, proved to be an even less diverse institution than UMass-Amherst. With only a small fraction of the amount of students at the neighboring University, the lack of diversity was even more obvious among students and faculty alike at this far smaller college. Help was also available at Hampshire, but he still had a comfort issue asking professors or somewhat unfamiliar individuals for help.

> Services, once again, were accessible and they did have some great tools I've carried outside my college career, but once again, when it came to teaching assistant hours, or actual hours, although it was smaller—I still was hesitant.

Breaking through the barrier of being "that guy who needed help," and not necessarily feeling familiarity among those with help to offer, kept Antonio at a distance. Antonio explains how this would also play out in his STEM based classroom experiences, especially when students of different backgrounds were challenged and how he noticed different people would comparatively respond based on comfort levels.

> At Hampshire, I would say the classes that leaned more towards computers and computer science or mathematics. For example, this class, it was minds, brains and machines,

minds computers and machines, something along those lines, that studied the parallels

between the human minds and, and machines. And not necessarily artificial intelligence

or robotics. But that class was mostly White, and maybe it had something to do with

preparation for that class, but I felt there was a difference between me and the other

classmates, not only very visual but just the willingness to participate or show their

ignorance. Because it wasn't like everybody was right, but clearly, other students were

more comfortable with displaying what they didn't know. And I mean that's cool that's

what school's about, but I do think that kind of hindered my progress. Even in the

kinesiology program at UMass. Once again, larger numbers are going to entail a larger

number of a particular demographic, but, for the most part, a lot of the students were

White and I do think that hesitation to participate was felt. There were other students,

once again, who were eager to do so, I don't know what their reason was for it, but I

know I just didn't want to be that guy who didn't know what he was talking about in a big

class.

My biggest problem with the role of race…is the immediate identification. Persisting

in college, when the experience is fun and socially engaging, is something Antonio clearly

understands as the reality for many students. However, when the climate is "less than

welcoming," as Antonio has described both UMass and Hampshire for minority students, it

becomes even more relevant to reflect on the value of the education and the purpose behind

pursuing the particular degree of choice in the first place.

I don't think I was kind of familiar with my entire reason for going to, to college, whether

able to kind of understand its real world implications or applications. I've had a couple

years of struggling and understand why and how you need to be educated in order to live the comfortable life you're expected to, or want to live.

Antonio, compares the struggles for those from lower socio-economic backgrounds with those who are more privileged without having the added burden of needing to work while going to school.

There are plenty of students who also don't necessarily have that real life fire lit under them to say, "You know, this, will be helpful, helpful through this." There are students who of course will have to pay rent after college but still get their degree…I think people will, more of my background, are taught to not use so much because you kind of need it to, to collect your resources.

However, relying on his parent's financial ability to pay for his own college education was something Antonio felt he was at least partially responsible for as well.

You know my mom's not the greatest in terms of finances. She's in a, you know, a decent amount of debt, and I think if I hadn't gone to [private high school] or college…maybe somewhere in my mind I knew that I'm going to have to contribute at some point but the immediate situation was my mom had it covered.

Antonio's deep introspection and awareness of the many obstacles involved in obtaining a coveted STEM degree, as well as the various shortcomings of many of the institutions he has attended, allows him to pinpoint areas of needed improvement in order for underrepresented students to obtain. He explains the situation and how he [and other URMs] may not have been fully prepared for the adjustments needed to be successful.

I overestimated the ability of, you know, the administration and the schools or those particular programs to support those in my situation, other minorities who maybe didn't

participate so much, were a little fuzzy on what they were supposed to do and I understood that when you went to college you're pretty much responsible for what you did, but in reality, you know not everybody is prepared in the same way.

For Antonio, understanding a student's needs has simply been a common sense issue. But he expresses concern that for minority students, a common sense approach is often lacking, especially around providing assistance in STEM. At Hampshire, Antonio received nearly $50,000 per year as a package to attend (including dormitory provisions), yet the total cost was nearly $61,000 per year. This forced him to work "torture jobs" to make up the $11,000 difference. This he explains, especially for students of comparatively modest backgrounds, makes finding time to juggle a challenging schedule of classes, along with a work schedule and life, overwhelming—especially when people "don't necessarily get you." His description of these undermining realities, including what could have been done to keep him there, is particularly revealing.

> I don't think there's a lot that could have been done. There were just too may stressful factors. I was working two jobs because they gave me a substantial amount of aid but, bottom line was, I couldn't pay for completing anything. So, it costs sixty-two for me. They gave me fifty-one at first. I gave them my all saying, "Listen, that's not going to happen. I can't go." But they gave me like fifty. It can be fifty, I think they gave me…11,000 maybe, 10,000 more. So I was just shy, and I told them, and they said that was best they can do. I wanted to go. I decided to pick up those torture jobs and even when I cut one, it was still kind of balancing that and the classes that I quite didn't understand because when I got there, I thought maybe I had some requirements to do. So I had that buffer of time doing okay in some classes, some classes that weren't very

necessary for my degree, but then they told me that I could just get and go to some more classes that were relevant to my program and I think that is what set me up to not be the most successful. But if they could have done anything, I would just say have somebody who could understand what it comes down to. I didn't feel like a lot of the faculty knew where I was coming from. It seemed like such a big mystery when minorities aren't succeeding in these environments and I could see why it is to people who aren't in that situation but I think it's very simple.

Antonio continues to elaborate on people's perceptions about his ability to succeed in STEM based on his race.

I think my biggest problem with the role of race in these pursuits [of STEM degrees] is the immediate identification. You know, somebody sees me, and they know me. And I think people of color, or minorities, feel that much more than the majority, White male, or something…you can't assume anything…I mean, as a Black male, I do it to everybody else. Everybody does it, but there are fine lines all about that, you just really can't cross, and it makes things a lot more than they need to be I think. And I think that played a huge role in going for these degrees and people will argue there tend to be a lot of Asians or South Asians that succeed in these programs, STEM programs, so why is there that difference there?

I think Hip Hop has played a role in my ability to dream wildly. Antonio continues by providing examples of how he is also not immune from making generalizations about certain people, something he regularly did throughout college. He reveals that "someone who I relate to" is someone who shares the common thread of Hip Hop culture. He explains, "I would say there was people who identified with that culture who kind of served as an unconscious screening

process for being my friend. If you could identify with that, I was more likely able to identify with you."

Throughout his experiences in the classroom, however, Antonio found very few that he would identify with, and subsequently studied with, who shared this similar culture. This was disappointing to Antonio, as someone who inherently relates to Hip Hop culture. He documents how he has continuously identified with Hip Hop, relating many subtleties in the culture with his own experience within various higher educational STEM based cultures. As someone who is not currently in college, it is clear Antonio still wishes to eventually earn a STEM based degree. He cites the ability of rappers to dream big and boldly, believing they are on the right path and will eventually make it, as similar to his own reality.

I think Hip Hop has played a role in my ability to dream wildly. If that makes sense? It has given me just that ability to elaborate on this train, so, I want to say idealized glamor, but to achieve more, not be so content with where I am. You know? It's nice to be content with where you are, but given where I came from, I think it made sense to want more…I think it's the common story told, particularly in rap and even in Hip Hop culture, all the things that come with somebody who stuck to their guns, until they made it and I think that kind of forwardness. And every time I hear this story, Isaac Newton and the creation of calculus. You wanted to know this one thing and came up with what shaped the way we send people through the sky. The way we look at, you know, and the cosmos and many other applications, like, Alan Turing, and his personal struggles, not only just being a brilliant mathematician, but, just leading his lifestyle as a gay male. Was it, 1920's, or something? It's just awe-inspiring.

Just stick to your Dmitri Mendeleev. For Antonio, Hip Hop culture has been the arena where achieving one's dreams are not only possible, they are a likely probability. "I would say the exponential growth [found throughout STEM courses] and the interest that it [Hip Hop] collects are very similar." He expounds on this by revisiting the crash course video series on astronomy he is so fond of watching.

> Yeah, so their astronomy section now, the host will keep drawing back to how we have so much progress in the field of astronomy when maybe a thousand years ago, which is nothing in comparison to the time of the universe. People were just looking up at stars and being able to, just like, "What's that?" Now we can see light-years past that and Hip Hop obviously had its humble beginnings and now it's in almost every facet of American culture.

> Antonio concludes his time by again comparing what some giants in Hip Hop have been able to achieve, somewhat fueled by similar passions and dreams as those held by many with a love and curiosity for all things STEM—much like himself. He closes with advice, perhaps—for himself, comparing the similarities of STEM culture and Hip Hop culture.

> I mean, just learn as much as you can, but keep forward and know you're in the right place. I don't say go with that gut feeling, because I feel like that's unscientific, but a lot of people who felt that they were right and their theories are, or whatever it is, discovered or created are still here today. Just stick to your Dmitri Mendeleev…His story is just incredible. How are you so certain that this is going to be a set element, or it will show up on this part of your periodic table? I think a lot of rappers, whether you agree with them or not, have that certainty of their ability and that boldness that's in Hip Hop or even dancers. It's just, like, "I am that guy." Just, chronically, "I am that dude." But to kind of

embody that, I think those are two huge parallels between the fields that can be stressed upon. I think that students can learn, I mean, a lot about life regardless of self-esteem or self-image…I think just that, the courage to keep pursing what is obvious to you is shared between both…I would say just once again, you got to have courage. The courage to keep on forward.

Lauryn's Story

Lauryn begins.

My name is Lauryn. I'm a Black woman from [the South] and my family is African American, so we've been in this country for generations through the Trans-Atlantic Slave Trade and stuff like that. I chose to pursue a STEM Degree because a lot of people from Black backgrounds, or immigrant backgrounds, whatever, their parents sort of think success is being a doctor or a lawyer. Things like that, regular things like that, so and I've always, kind of, been interested in science and how things work. I'm just a curious person, so I was like, "hmm, maybe I'll just do that." You know, that aligns with my interests and everything like that so, yeah, I chose to pursue a degree in behavioral neuroscience. And I did that because it was half of what I had to do, I thought, and half of what I liked. The bio was for pre-med, I thought, and then, psych was what I really, really wanted to do.

I chose Northeastern because of the Ujima Scholars Program, not because of what I majored in. It becomes quickly apparent that Lauryn is all business. However, she manages her matter-of-fact nature in a charming manner, and thus exudes authenticity worthy of immediate respect and admiration. She speaks bluntly of her own high standards and expectations without a hint of cavalier from someone with her obvious level of competency and polish. She recounts her

own preparation, grounded in her mother's fondness for education, which ensured Lauryn's early exposure to STEM and to big ideas in general.

> I took calculus in high school and my mom had always put me in, like, gifted throughout the summer, like pre-college programs and things like that, so, I had had a little bit of a taste in it. Took me to cadaver labs, and things like that. My mom's really big on education, so every time she would get the chance, she will take me out to museums, out to science museums, different things like that. So I always had a love for science, so that was that, was the contact that I had in school and at home. But my parents don't do anything, STEM or anything like that.

She explains what landed her in Boston, "I chose Northeastern because of the Ujima Scholar's Program, not because of what I majored in, and I actually came in the undergraduate studies program, or an undeclared program, just because that's how the scholarship program worked." Ujima, in partnership with the John D. O'Bryant African American Institute, has more recently come to be known as the Ujima Global Leaders Program. The Ujima Scholars Program dates back to 1972, and has historically worked in partnership with the Department of African American Studies—anchored within the African American Institute (AAI) at Northeastern. Much like Foundation Year, it also provides students with respite from the larger campus culture, while still stressing the importance of global citizenship, and issues related to diversity and inclusion. Lauryn continues to explain some of the other underlying reasons she came to Northeastern.

> That's the reason that I came here, because of that scholarship, as well as Northeastern University gave me a good financial aid package and I wanted to go to college in a city, so it was more external factors than the type of degree that I wanted, because I thought

that I could have gotten that degree anywhere…It's, like, I can do behavioral

neuroscience anywhere.

Lauryn also explains a bit of the evolution of Ujima and how that fit with her needs and

concerns.

> Yeah the Ujima Scholar's Program started off as, like, a college access program for
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> Boston-area students, but over the years, it's transitioned into something a little bit
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> different which, it's now a, like, high-honored scholarship at the university. And so, I was
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> one of the transitional classes whereby I didn't really need that; a lot of the students from
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> before had rigorous academic counseling and things like that to make retention rates
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> better.

> Clearly, after hearing Lauryn expound upon her own high school experience and how it

prepared her for majoring in STEM, it is evident Lauryn did not "need" to be in any sort of

college preparation program since she had already taken care of that while in high school. She

compares herself to other students, however, who had already further gamed the system well in

advance, but recognizes she was still more than adequately ready for the rigors of a college

STEM program situated in a rigorous research university.

> I would say that it [high school STEM coursework] prepared me a lot. I took AP biology.
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> I also took a physiology class, so that prepared me for those classes. I also took chemistry
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> in tenth grade so that, kind of, prepared me. But if I had taken AP chemistry, I probably
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> would have been a lot more prepared. To my understanding, a lot of these students take
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> AP chem and then AP bio in high school and then they retake it in college just because
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> that's what medical schools like to see; that you're taking a college-level course, actual
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> college-level and not AP and they're just a lot more prepared, in a sense. So they're taking

a class for the second time so they have all that information to use which puts them at an advantage, but I wouldn't necessarily say that I was at a disadvantage. I went to private school, that was pre-college, things like that.

They're designed to weed students out and I don't like that. Now a third year student at Northeastern, Lauryn recounts her own desire to enter college with a plan to finish all of the general requirements for pre-med, while hoping and expecting many of those same courses would fulfill many of the same requirements of her true major—which she would later declare as behavioral neuroscience. She explains the details of her choice of major.

> But they didn't [fulfill both requirements] really, so it was behavioral neuroscience and then pre-med, as well…There is not a pre-med major here, but since, like, so you have to do the groundwork yourself and realize, okay, I have to take Bio 1, Bio2, Chem 1, Chem 2, Calc 2; things like that. Make sure you hit everything so that you'll be a good candidate for pre-med, for medical school.

She also subtly explains the lack of challenge she found within some of her coursework, while explaining to what degree college coursework in STEM met her expectations.

> I expected to be doing things that I liked. I expected to be learning about things that interested me because, obviously, people give you the image of college that, you know, you're doing specialized work around things that you find interesting because you're majoring in what you want to major in, right? But I ended up taking classes that were very basic level. Everyone was learning the same thing and that's not really what I wanted to do, so I had this understanding that I would be learning on a more niche-level, and it was more on a broad-level. And your expectation was so that you would be more challenged, or was it such you'd be interested in doing things you hadn't learned before?

Lauryn next explains a key point about an element of competitive STEM programs which she found disheartening, especially for other students who did not have the same level of academic preparation she was fortunate enough to have received. She details how the nature of these more rudimentary classes were a "weeding-out process" to see who was prepared to handle the work at such a highly selective research institution.

It's kind of tricky because the tests that they design, they're designed to weed students out and I don't like that. I don't like that at all and that makes me recoil into myself, not being challenged per se, but the idea that there is this systematic thing in place to try and make students not do what they want to do, you know? That makes me sick.

Lauryn provides a bit of clarity on a not so well-known fact about pre-med students. Namely, how many of them are not actually in pre-med degree programs, because these "majors" simply don't exist at most institutions. Instead, they are often tracks towards achieving acceptance at medical programs after attaining an initial degree—normally in something STEM based since the credits required consist of many core STEM courses. She explains how the next best thing is to major in a general STEM discipline, often with similar "weeding-out" courses such as calculus based courses, biology, or chemistry. Yet, many students who do persist often retain their own "pre-med" identities while working to satisfactorily complete coursework required for other institutions that prepare students for medical careers. She clarifies this point succinctly, and how this felt as a result.

A lot of students who are in STEM programs are seeking to eventually get pre-med degrees. So the fact that my pre-med courses were so salient in my identity as a pre-med student was something that I was real surprised by. I think that, I thought that I was going

to be majoring in behavioral neuroscience and I ended up majoring—it seemed like I was majoring in—pre-med, and minoring in behavioral neuroscience.

I don't see a lot of faces that look like mine. When asked more about her experiences within her STEM major, particularly about the diversity within the degree program, Lauryn also clarifies another often misunderstood reality.

I would say that there is a lot of diversity, but there's a caveat to that, so the diversity is international students, which is fine and everything like that we're all going to be global citizens in the future. I feel that way, and that's great to be exposed to a lot of different cultures and everything like that, but I think Northeastern sometimes forsakes [domestic] diversity for foreign…I don't see a lot of faces that look like mine.

She was somewhat surprised to see some other Black women in her STEM courses and within the major, something surprising for a less-than "domestically diverse" institution—especially if those students were not part of a program like Ujima.

There were other Black women there. I saw a couple of other Black women there, so I wouldn't, I mean, this school is majority White. So, obviously, there is only so much diversity that there can be. But I did see a good amount of Black women who were there, so that was interesting to me—not very many Black males but Black women.

Lauryn specifically clarifies the kind of diversity she sees within the program, in light of her previous answer. "It was mostly like White and Black and then there were some Latinos and Asian, too. But most of those students are, like, the international students in, like, the business program, or, like, pharmacy and things like that."

Developing her thoughts on the general lack of brown and black faces on campus, specifically non-foreign students, she explains how she benefited from the supports of the

African American Institute which houses Ujima, but expressed concern for others who did not have such supports in place.

> At the African American Institute, they have tutoring during certain times, so I would take advantage of that. There is also peer tutoring that happens in Meserve hall. I would go to office hours, so I had the, the help was there for me. I didn't feel left behind or anything like that…They were so helpful, like I said, I was a Ujima Scholar, so I was, kind of, like bread in the institute. In the African American Institute I knew all the staff, knew all the people coming in, and I felt like I really had a community there. But I can't say that for other students of color; people will come to Northeastern's Black Student Association, which I'm a part of, and they'll feel at home, but if they don't ever step foot into the institute, then they can get, you know, washed away out there. So, it's pretty sad, but I felt like I had a community to rely on…

This potential lack of support for others on the margin, for Lauryn, is only exacerbated by the general "colder" cultural climate of the North compared to that of the South. She expresses how in the South people are more "congenial" and tend to look out for each other, something not typical of what she has come to experience in New England.

I didn't really like the vibes here. Lauryn speaks to looking forward to an opposite experience, with a return to the South for graduate school.

> Since I came to Boston and I found out that there were just, I didn't really like the vibes here…Yeah, I'm all set, you know, not replying to text messages and things like that…I was, like, I'm going down south, like, deep down south, so I was thinking of Duke Medical.

Lauryn, expresses the fact that students of color who are not supported by programs with an understanding for some of the concerns diverse learners commonly have are unfortunately left to fend for themselves. They often do not ask for, or receive, the type of help they often need. The cultural norms of students in a competitive "Northeastern" university, are already different regionally from what she is accustomed to in a more collaborative and congenial Southern setting. She explains that in core STEM courses this is exacerbated across the board, and is only amplified for students from different cultural backgrounds.

> They kind of throw you to the wolves. Not to say that Northeastern doesn't have rigorous academic advising, I appreciate that, but it's, like, their pre-med program is of your own volition. And I'm not saying that I need my hand to be held or anything like that, but, you have to go to a meeting here, a meeting there and then they'll check up on you a little bit later to see, like, "Oh, have you taken all your pre-med classes? You should be getting As. Hopefully, you're getting As." You know? And then you keep going and then it's like, "Oh, you should be applying to medical school right now." Just, like, it's so hands-off. Individualistic. A lot of the students here, they don't care about your success and I grew up in a really strong community and it's, like, "Yeah, let's do this paper together." or, like, "Let's try and research about this paper together and we'll write our own separate papers." or, "Let's do this, like, you know, let's do our labs at the same time so we can ask each other questions." Students will look at you dead in the face and be, like, "I don't do that."

The impact this made on Lauryn is perhaps best explained by her ultimate switch of majors out of what she perceives as a colder, more "individualistic" atmosphere of neuroscience majors, filled with pre-med alpha personalities, and into a much more welcoming major of psychology.

In psychology, it seems that people are more willing to help each other get ahead.

"People in psychology are just a lot more caring," Lauryn declares her beliefs.

> They care about your success and they are willing to chat with you after class about something that you have a question about, whether it be an existential question about the material that we learned or just, like, oh, can you re-clarify this part of developmental psych.

She further elaborates, while providing a plausible explanation for why the stark difference between cultural norms which seem to differ across disciplines.

> In psychology, it seems that people are more willing to help each other get ahead 'cuz it's not like I'm at a loss if I help you out, you know, whereas in pre-med I feel like everyone thinks and, this isn't to say that there aren't people in psychology who are just about their own business because there are. Everyone's trying to get into grad school and there are only a limited number of spots but even for medical school, I feel like people feel an external pressure for some reason to do so well that it would "hurt them" if they helped someone else to do well.

Perhaps this aspect of her previous major rubbed off on her enough that she decided to project a similar demeanor as well.

> So, that's how I would say interaction with my professors, interaction with my peers is. I just, I kind of don't like talking to people in class, like I'll be friends with them and be nice to them and get notes from them, but I just don't prefer to make friends in class but, that's not to say that I'm mean to people in class…I'm a lot more amicable with my classmates.

The intensely competitive atmosphere, especially by those students taking heavy-duty STEM based coursework in order to transfer to competitive graduate and medical schools, has helped to drain Lauryn of her desire to continue in such an individualistic culture. Her decision was made final to switch majors after a conversation with her mom before the second semester of her sophomore year. She recalls what she told her mother, "I don't think, this isn't making me happy anymore." She chronicles the thoughts that led to this decision.

> Being a behavioral neuroscience major, and it wasn't necessarily behavioral neuroscience, but that was, sort of, tied to the whole pre-med thing that I wanted to shake off. I didn't want to go to medical school anymore and I also didn't want to do, I didn't want to have a behavioral neuroscience degree and then have to do research for the rest of my life or then go to grad school for, like, linguistics, or something like that. That's what a lot of people do, so, I just wanted something different for myself, and something that I thought was more broader for myself. Something that I could dive into and be fully interested in. And also the work was difficult, and the fact that I didn't want to do the work made it even more difficult for me.

Of course, she explains, that the two degree choices did have some similarities, as both are still housed in the College of Science. While neuroscience predominantly looks at the science of the brain, psychology examines the "why" of the ways of the mind. This "behavioral" aspect of the neuroscience major was the aspect she particularly enjoyed, and still gets to explore within psychology. "I really enjoyed learning about the biological basis of why people act the way that they do, which is what I'm learning about now, sort of, but more on a cognition level, so, like, learning in-depth about neurons and things like that."

The style of learning that takes place within Lauryn's psychology major is a major point of appeal for her. She explains, "It's a lot more of a free-flowing exchange, rather than it's like, you teach me this, I learn this, I then regurgitate it to you." She again adds depth concerning her decision to leave the original STEM major.

> Well, a lot of it was my own personal idea of myself and what I was doing it for and I didn't think I was doing it for the wrong, for the right reasons. It's not something that I enjoyed, but not enough to be doing for the rest of my life, if that's what we're going to school for here. Right? I also think that something that contributed to me leaving the program was, not the difficulty of the work, but the way in which the work was being distributed. I really don't believe in testing at all, but I have to take tests. I don't think though that's the way that students learn, but a lot of universities think that way and feel that way and, especially, in STEM programs. I think that they try to make it extra difficult for no reason and it's, like, if, I'm learning the information, yes, but I'm spitting it at you on the test and that's how a lot of people feel about standardized testing, but I think that, like, multiple choice testing, for, even collegiate students, it's the same way; especially in STEM majors. It's like, they try and feed you all this information and it's like, "Can ya learn it? Can ya learn it?"

For Lauryn, this is fundamental, and part of the way she feels she has been both socialized and how she learns differently as a Black woman. Though she is not claiming this is perfectly understood within her psychology major, it is a more receptive environment in terms of embracing different styles of learning.

The way that I learn as a Black person is somehow different from the way that European's standards of education have been formulated. Lauryn explains how not all

people necessarily learn the same way, and that it was not her experience that this truth was appreciated within her original STEM based major.

> I feel that the way that I've been socialized, or, not even socialized, I feel like the way that I learn as a Black person is somehow different from the way that European's standards of education have been formulated, just, like, inherently, and I don't know if that's because I'm Black or because I'm [Lauryn], but, I think that I just learn a different way, and the way that I'm being taught doesn't necessarily reflect how I learn. And I think that everyone's supposed to fit into this circular box, when I may be a square. You know? Because that's different, that's bad, and I didn't like that and I felt that really heavily. I felt that really heavily and there are a lot of, like, that's something that bothered me a lot, but I know that there are a lot of Black students who will just do whatever they have to do to get by and I'm not about compromising myself and my intellect and, like, how I process things for the greater, for the good of some for anything that I don't care about.

Lauryn, reiterates the theme of not wanting to compromise her beliefs, and also her feeling for the realities or hardship of others. She clearly is concerned about those who may not be making it due to systematic inadequacies with STEM programs—particularly for underrepresented populations.

Lauryn seems to search for potential solutions to the problems as she is speaking, while also trying to quantify the problem and her experiences in order to help me understand more clearly. Not only does she return to her theme of thinking about how other Black students would likely have to deal with the issue, but she also hits upon a reoccurring theme of this study— namely instructors seemingly trying to "trick" the students so that they will not reach attainment.

>Yeah, and I don't even know how I would speak up about it because that's a systematic thing; that's how the whole university chooses to go about their business. It's like teaching in a certain way; that's an education problem. That' not a necessarily Northeastern, or I think it is a STEM problem too, because that's how a lot of STEM teachers choose to teach. It's just, like, they throw a lot of information at you and then they make the questions, like, difficult and sly on purpose, so that most students won't, finish, get across the finish line. But I don't know if a lot of other Black students felt that way. Because I know that they would just, they would just do well…Yeah, like, "Can you spit it back around?" and not even "Can you learn it?" They don't even care and it's like, dang, my doctor doesn't know anything about hemoglobin but he's taking my blood pressure.

Though she is clearly concerned with potential solutions, she instead focuses on the results of the experience.

>That [experience] was a deterrent [to consider staying in neuroscience] because I felt like I was, A, compromising myself and, B, I felt that I wasn't welcome. They made me feel unwelcome…You know, not everyone learns in a singular way just because they aren't learning the way that the teacher is saying that they should learn doesn't mean that they're dumb.

Hip Hop has always been a voice for the voiceless. Though Lauryn hasn't revealed herself to be a musician or poet, she clearly speaks with a definite cadence and rhythm of a powerful spoken-word artist. Her timing and choice of words is purposeful and artistic. It is at this point that my questions start to explore a bit of her own background with Hip Hop culture. Almost sensing the connection between her viewpoints, especially her feeling "unwelcomed" in

STEM, and the role Hip Hop culture potentially plays in providing a welcoming atmosphere, she begins right in.

> I think you probably know more about this than I do, but, Hip Hop has always been a voice for the voiceless and everyone says that, and I appreciate that a lot because I feel like I can share the sense of it. I think that that's important; not to co-op to the voice of the voiceless, but to give the, like, show the voice of the voiceless.

Lauryn relates how elements of Hip Hop culture connect to that of STEM. She explains the issues of integrity, grit, and once again—not wanting to have to compromise. The required "stick to it" factor that one must have to persist in the Hip Hop game and the STEM game are, for Lauryn, strongly interwoven.

> You have to have a certain grit to get through Hip Hop as you need to get through STEM? You may go into music thinking, "I'm gonna make music for myself and I'm gonna share it with the world," but that may not be what the world wants to hear, so you have to think about, like, "Am I gonna change who I am because of this and stay doing something that I think that I love?" or am I going to just not do it at all and, like, love it from afar? You know? And that was my experience with STEM.

We continue a long talk on Hip Hop, as we somewhat "deviate from the script." It becomes very apparent Lauryn is conflicted between the positive aspects of Hip Hop and the form of rap music and videos that dominates commercial popular culture with misogynistic lyrics, symbolism, and overtones. She elaborates on how detrimental some of it can be, to the point that she finds some people reciting the lyrics are not even cognizant of the craziness they are reciting.

> I was like, "oh my God," and then they have these videos things, it's Black women, right, which aren't even in Black videos, like aren't even in Hip Hop videos that much anymore.

Anyways, but it's like they find these Atlanta girls and then they have them twirling their weaves and they're singing along to it. It's like, "oh my gosh." That breaks my heart.

Lauryn is next able to relate this back again to her STEM experiences when asked to make the connection.

You know, like, people consider Iggy Azalea Hip Hop and A Tribe Called Quest [Hip Hop] simultaneously, right? So I think that, except, like, the field of STEM should accept all types of learning styles; all the different ways that people learn and the different ways that people are able to learn and then report back information, so that it's better for students to be able to actually retain the information instead of, just, regurgitating it.

After asking her what role it Hip Hop has played in her life personally, she explains how it has always been there in her life and through her family.

Yeah. My mom thinks that *The Miseducation* [referring to Lauryn Hill's Album] is the greatest Hip Hop album of all time. Pretty cool. I agree that it's a great album. I grew up, well I was born in '95, so, like, my parents were listening to music from the '90s all when I was growing up. Even though that was more some in the 2000s, and I think that Hip Hop culture is a large part of the Black experience, a large part of popular culture experience right now. So, yeah—Hip Hop has influenced me.

Summary of Research Results

The findings of the narrative presented in this chapter were determined directly from analysis of participant interviews. The analysis was undertaken in order to answer the research questions: Which factors do URM students who have left STEM degree programs feel played the most significant roles leading to their own attrition? How do URM students feel STEM education in higher education institutions could be conducted more effectively to reach and

retain URM students? What role could the infusion of elements from Hip Hop culture into various aspects of higher education play in potentially alleviating the issue of attrition for URMs majoring in STEM disciplines?

In response to the research questions, participants detail unwelcoming cultures within each of their STEM programs, feelings of isolation due to lack of racial diversity, lack of positive role-models, and an under appreciation for the potential positive role of Hip Hop culture within their STEM programs. Findings of the study also revealed a consistent theme concerning the participants' solid belief in their own abilities and adequate pre-collegiate STEM coursework and preparation, sufficient enough to be successful at the college level. The larger theme of a "chilly" STEM atmosphere was only exacerbated for these URM students, where race was an undeniably clear and ever-present factor during their higher education experiences.

Consistent among the themes students detailed in their collegiate academic careers, was the feeling of unnecessary—and often intentional—impediments and roadblocks keeping students from easily reaching attainment. Multiple times in this study, participants used phrases such as "setting me up to fail" or trying to "trip me up" to indicate intentional trickery to "weed out" certain students. These perceived attributes of the various institutions and their respective faculty and staff, further helped to develop the larger overall theme of "feeling unwelcome." This directly led to changes of initial STEM majors, or attrition from the schools altogether—thus a lack of degree attainment in STEM.

Chapter V: Summary of Findings and Recommendations

Introduction

The central purpose of this study was to help increase degree attainment among underrepresented students who major in STEM disciplines at predominantly White institutions by understanding the key factors which led to attrition out of these majors. Additionally, by examining the cultural experiences of URM students initially enrolled in STEM degree programs who also identify with the culture of Hip Hop, the usefulness of including elements from Hip Hop culture into STEM curricula, pedagogical delivery, or STEM departments and campus culture could also be ascertained.

A dearth of research argues that low rates of degree attainment among underrepresented populations is one of education's most daunting challenges; this is only exacerbated by high rates of attrition during the first year of college for URMs who are often first generation students (FGS) with lower cultural capital (Bourdieu, 1986) than their traditional peers (Chen, 2013; Hurtado et al., 2010; Majer, 2009; Melguizo & Wolniak, 2012; Rask, 2010). Yosso (2005) detailed how these capitals also include aspirational, navigational, social, linguistic, familial, and resistant capital as well. Yosso (2005) argues if these forms of capital were recognized they would allow informed educators to draw upon the multiple knowledge bases students of color already bring with them from their communities and homes—ultimately making their experiences better. This study set out then to directly consider the lived experiences of four individuals from historically marginalized populations (all African Americans) who majored in STEM at various PWIs, but for a variety of factors did not complete a degree in a traditional STEM discipline.

The role of Critical Race Theory as a lens in this study. The findings of this research were grounded in Critical Race Theory (CRT) within education (Ladson-Billings, 1998; Ladson-Billings & Tate, 1995; Tate, 1997) as the theoretical framework which served as a lens to investigate the results emanating from the research questions. When utilized as a lens in education, CRT examines how various institutional policies and practices continually perpetuate inequality along ethnic and racial lines while exacerbating White privilege, even though these policies are often heralded as "color blind" (Ladson-Billings & Tate, 1995; Solórzano, 1997; Villalpando, 2004; Yosso, 2005). Tate (1997) similarly emphasized the potential role schools are positioned to play towards liberation and social justice in the fashion which hooks (1994) and Freire (1970) have previously called for. Though schools often possess great potential to empower and emancipate, they are far too often experienced by URMs as conduits of oppression and marginalization, further impacted by institutional racism (Yosso, 2005). This study captures four African American voices who have experienced marginalization and alienation within their STEM programs; as a result they all left those majors behind and sought out more welcoming and inclusive degree programs during their academic careers.

According to Hiraldo (2010), the role of CRT in Higher Education centers on five tenets: "counter-storytelling; the permanence of racism; Whiteness as property; interest conversion; and the critique of liberalism" (p. 54). Hiraldo (2010) argues only if higher education institutions truly commit towards more diversity and inclusion by systematically removing deeply ingrained societal disparities which thrive on college and university campuses will the changes which CRT calls for actually occur. Hiraldo (2010) further contends if change is an institutional priority, than merely attempting to implement policies at PWIs which increase the quantity of enrolled students of color is not enough, rather increasing campus initiatives which place culturally

competent and diverse faculty, staff, and administrators in key positions is a far more effective way of increasing campus diversity and inclusion. For those institutions seeking justification for such change, this study has provided a counter-story, which explores similar themes of racism experienced by four African American STEM majors at various levels across different higher education institutions who did not reach attainment in a STEM discipline.

CRT in conjunction with narrative inquiry. Clandinin and Connelly (1994) first proposed the usage of narrative inquiry as a research methodology, which in itself reveals a theoretical influence attributable to John Dewey (Huber et al., 2013). In utilization of this methodology, Casey (1995) adds that narrative researchers possess excellent opportunities to defy prevailing powers and practices which seek to marginalize. Ladson-Billings and Tate (1995) highlight the importance this has upon the inflicted, by explaining the importance of the theme of naming-one's-own-reality, which is present throughout the history of CRT and reintroduced as a tool for educators seeking to heal the oppressed therapeutically.

A factor contributing to the demoralization of marginalized groups is self-condemnation. Members of minority groups internalize the stereotypic images that certain elements of society have constructed in order to maintain their power. Historically, storytelling has been a kind of medicine to heal the wounds of pain caused by racial oppression. The story of one's condition leads to the realization of how one came to be oppressed and subjugated and allows one to stop inflicting mental violence on oneself (p. 57).

Likewise, throughout Ladson-Billings' seminal work (1998) on CRT and its relevance in education, she chronicles how capturing the *voice* of members of populations marginalized by race has been a historical goal of CRT in an attempt to alleviate the social burdens imposed by racial hegemony. This process enables Ladson-Billings (1998) to expand on the work of key

pioneering CRT theorists and researchers (Bell, 1987; Crenshaw et al., 1995; Delgado, 1990; Tate, 1997) by illustrating how providing a narrative representing people of color is necessary to highlight the deeply pervasive nature of racial marginalization across a wide away of social structures—including educational institutions. It is in following this long tradition of evoking the power of narrative inquiry as a conduit for social change that this research study was undertaken to work in conjunction with CRT as the theoretical lens. The therapeutic value of providing a voice for the participants in this study cannot be understated; it was extremely clear the value this process had upon them, which in turn motivated this researcher to accurately retell their compelling stories.

Research Questions

The central research question for this study was: Which factors do URM students who have left STEM degree programs feel played the most significant roles leading to their own attrition? The supporting question for this study was: How do URM students feel STEM education in higher education institutions could be conducted more effectively to reach and retain URM students? An additional sub question emanating from answers to this supporting question was: What role could the infusion of elements from Hip Hop culture into various aspects of higher education play in potentially alleviating the issue of attrition for URMs majoring in STEM disciplines? The interview questions were designed to provide rich descriptions that provided background on each participants' experiences to better illuminate their respective stories, while gaining a frame of reference for their potential suggestions and key insights. The interviews themselves took place from September to October of 2015, both on the campus of Northeastern University in Boston, Massachusetts and in the immediate vicinity, at a location of the participants' choosing.

Summary of the Findings

Key factors which serve to decrease attrition and thusly increase rates of STEM degree attainment for students attending traditional 4-year higher education institutions have been thoroughly researched (see for example Gasiewski et al., 2012; Tinto, 1993; Titus, 2004). Similarly, research with particular focus upon increasing attainment for URMs majoring in STEM fields has been investigated and formed the basis for much of this study (Allen-Ramdial & Campell, 2014; Chang et al., 2014; Perna et al., 2010; Seymour & Hewitt, 1997). Isolationism on campuses, and low-expectations held by faculty have been shown to produce strong (negative) impacts upon URMs—including eventual attrition (Chang et al., 2014; Hubbard & Stage, 2010; Hurtado et al,, 2010). The results of this study have confirmed these similar findings, while also recognizing that these investigations still may not tell the complete story.

Though poor pre-college preparation was often suspected as the key factor contributing to such attrition, slowly a growing body of research started to emerge proclaiming that a lack of student engagement in STEM was a more important factor. This study also presumed that a lack of proper STEM schooling before college was *not* the case, and that something else was likely at work. Chang et al. (2014) argued that if the level of student high school STEM preparation was substantially increased it would hardly guarantee a marked improvement in STEM degree completion unless introductory college course engagement is significantly increased. This lack of engagement has increasingly become understood as resultant of the byproduct of attitudes and behaviors of professorate who teach the coursework, and less to do with how resourceful the students were when they initially came to class (Chang et al., 2014; Palmer et al., 2010). This study of four African American STEM majors was no exception—all four were highly motivated with above average pre-collegiate backgrounds who found the attitudes and beliefs of faculty,

staff, and students to be unwelcoming, alienating, and detrimental towards their hopes of attainment. Even with their strong educational backgrounds, where every student studied was part of some sort of initiative or bridge program during the first year (or longer) designed to enhance cultural capital and provide URMs with potential mentorship and a more welcoming climate—it was still not enough to stave off attrition from STEM.

The findings of this study strongly aligned with research conducted by Gasiewski et al. (2012) which found that introductory courses at many highly selective institutions do little more than to function as "gatekeeper" courses, which often do a far better job screening out—than nurturing. Further, this study also supported secondary claims by Gasiewski et al. (2012) that demeanors and attitudes of professors often implicitly and explicitly convey messages which influence the engagement of students in the classroom and that those professors employing humor, demonstrating genuine care for their students and subject, and exhibiting a passion for the material are likely to be viewed as highly engaging. Likewise, Seymour and Hewitt's (1997) seminal study across seven universities researched over four hundred STEM declared majors who did not switch majors by comparing them against those who did switch majors. The results concluded that the unwelcoming culture in the discipline had far more to do with students leaving the major than any lack of student ability or preparation (Seymor & Hewitt, 1997). This again was affirmed in this study where all four participants cited extremely unwelcoming environments, only exacerbated when compounded by various experiences involving racial stereotyping. Programs, it would seem, are not enough to prevent attrition if the culture outside of the given bubble of support and hospitality are not mirrored on an institutional-wide basis—especially within the respective STEM departments where many of these students have spent a large portion of their collective time.

In contrast to unwelcoming climates which URMs often experience in STEM, the positive effect belonging has at HBCUs is well documented and clearly evidenced by how these institutions consistently turn out better numbers of URMs than their comparative peers at PWIs (Hall & Martin, 2013; Museus & Liverman, 2010). Scenarios where URMs work with other students as mentors with positive self-images and high self-efficacy have produced excellent results on urban campuses with greater than average numbers of URMs (Lansiquot et. al., 2011; Majer, 2009, Myers & Pavel, 2011); there is no reason to believe these results could not be replicated at PWIs like the ones attended by the participants in this study. Incorporating Hip Hop culture, which already provides a welcoming and familiar culture for many URMs, is readily implementable within many urban institutions and STEM curriculums (Emdin, 2010; Hall & Martin, 2013). This sort of backdrop within STEM classrooms and departments would potentially provide an ongoing climate of welcoming cultural familiarity, which would not necessarily be shut off when first year programs and other initiatives inevitably come to an end. When similar ideas were propositioned to the students of this study, all four reacted favorably to the prospect of infusing STEM based courses and curriculum with elements of Hip Hop culture.

Critical theory, as it is applied to a Hip Hop ideology, provides a lens to view how to effectively reach and teach the traditionally under-represented minority student (Hill, 2006). Many of these students arrive highly skeptical of the role of governments and institutions; by incorporating community building via Hip Hop pedagogy they become potentially easier to reach (Edmin, 2010). Likewise, the incorporation of Hip Hop culture in higher education at the hands of a CRT pioneer has been one of the more recent key inspirations of Gloria Ladson-Billings (2014). She elaborately documents how her work with an innovative spoken word and Hip Hop arts program, *First Wave*, at the University of Wisconsin-Madison was an ideal opportunity for

progressive growth, expansion, and positive change. Ladson-Billings (2014) chronicled how infusing Hip Hop helped her undergraduate teaching change drastically for the better by empowering her with a reflective opportunity to make improvements in her teaching.

This study supports such an approach by practitioners after similar sentiments were vigorously reported throughout this study, thus affirming the many positive benefits incorporating elements of Hip Hop culture likely would have had upon all of the participants. Interestingly, Ladson-Billings is not only a CRT pioneer within education, but an advocate for the infusion of Hip Hop pedagogy, and the utilization of narrative inquiry a well. Ladson-Billings (2014) not only, endorses narrative as research tool, but similarly recognizes the power of Hip Hop itself to provide narrative voice for those students who use the culture as an outlet for self-expression, especially through continuous lyric writing and reciting of their own raps in a culminating final "cipher" where students "spit" their own poetry.

Discussion of Findings from Participant Narratives

Dana. Each participant was given a pseudonym based upon the first name of a classic rap artist whom the participant's characteristics most similarly embodied. Dana, therefore was a pseudonym based upon Dana Owens, also known as Hip Hop legend and mogul, Queen Latifah. The following is a breakdown of the themes which emerged after analytical note taking and multiple rounds of coding. These codes were crystalized with actual quotes from the participants, much like "one-liners" or "punch-lines" commonly popularized among rap artists in ciphers, song lyrics, and emcee battles.

- **This is your ticket out.** The theme of leaving a less than ideal home environment for the prospect of enrolling at an elite institution in a coveted STEM based major

- **I don't remember them being supportive**. The theme of lack of belief from instructors and administrators at her high school for her to get into, afford, and succeed at, an elite institution in a STEM based major

- **Why didn't you just have me do this before?** The theme of questioning ineffective traditional instruction versus the benefits of hands-on, lab-based coursework with engaging instructors

- **Why are you setting me up to fail?** The theme of believing STEM courses in college were designed for her to fail, especially as a black woman, but were set up for White males to succeed. Though she was set up with an initial bridge program with positive mentorship and support for URMs, this was not reflective of the support she would find within her STEM based major.

- **That's when I started losing faith in myself.** The theme of lack of support from caring instructors in STEM who did not believe in her ability to succeed

- **You're a weirdo.** The theme of not fitting in within a STEM environment as a Black woman, or not fitting in with her Black friends since she was perceived as not Black enough, and of a different faith than the majority of students and faculty at this institution

- **I remember always wishing that it was as easy to remember…equations as it is for the lyrics to a song like Hip Hop.** The theme of not incorporating Hip Hop techniques for useful memorization in her difficult to remember STEM course vocabulary—despite her insistence Hip Hop lyrics were always something she could vividly remember

The overall theme presented by Dana was that she did not fit in and did not feel welcome as a Black woman in a traditional science based major during her first two years of college. Though she did have some mentorship available since her freshman year while in a bridge

program, she did not receive enough mentorship within STEM to keep her from seeking out a perceived "less stressful" and "more-welcoming" environment found within her new major of choice—sociology. The lab based work she associated with STEM, and did well in, was not enough to make her want to pursue a degree from her elite college STEM program; she felt instructors were "laughing at her" and just expected it to be hard, because "that is just the way it is in STEM." As a result of feeling she was "floundering" in her original STEM based major, she left primarily due to an internal lack of support. She successfully graduated from this same institution as a sociology major and later went on to earn her MBA at another elite university due to finding success and greater confidence within her changed undergraduate program.

William. The name William is the legal first name of legendary rap lyricist Rakim. The wisdom and confidence of Rakim has endeared him to fans for generations; he is widely considered a highly complex lyricist and one of the best of all-time by many Hip Hop connoisseurs. The following themes emanated from William's interview.

- **You'll never get this; you'll never succeed in calculus**. The theme of a lack of belief from instructors that he would succeed in a STEM major, especially not at an elite institution like his instructor

- **I met a music professor who, who literally changed my life**. The theme of not having engaging instructors inside of a STEM major, yet having positive faculty mentor figures outside of STEM

- **There were six of us African Americans who were math majors**. The theme of isolation on campus within a difficult STEM major at an elite institution, and the resulting need for solidarity and grit among a very small group of same race students

- **You got to be twice as better than your competitor**. The theme of racial inequality on campus, especially in STEM, and the feeling of being set up to fail

- **There was nobody to say...you guys are talented, you guys are gifted.** The theme of a non-welcoming culture within STEM, not actively seeking attainment for its marginalized students

- **What are you all doing here? You all got the wrong major.** The theme of overt racial tension and low expectations found within the STEM major, and the dismissal of Hip Hop culture

- **Hip Hop has always been the tool that I have used…in order to memorize.** The theme of inclusivity within Hip Hop culture and its usefulness as a pedagogical tool

William's main themes were similar to Dana's. He felt constantly unwelcomed in his STEM major, and also experienced a feeling that he was being set up to fail within a program with low expectations for URMs within a top-tier mathematics program. William felt pulled away from STEM and instead towards his second major of music due to positive faculty role models and a more welcoming overall culture which embraced difference and individual talents and attributes of its students. He experienced strong racist overtones from faculty and students alike, which created a hostile climate for Black students majoring in a traditionally difficult discipline at this elite institution. His love for music and his intense passion for Hip Hop culture was not deemed relevant within his mathematics major, which he found disappointing since his affinity for mathematics was enriched by the many similarities he had always felt existed between music and math. William, unfortunately, would leave his math major just a few courses shy of earning a double major; instead he graduated from this institution with only a degree in music. He would later complete a masters and doctorate in music at another well regarded

institution and has gone on to become a successful educator and mentor for many students at an elite East Coast university.

Antonio. Big Daddy Kane (government name of Antonio Hardy) is a legendary rapper, widely mentioned alongside Rakim as one of the greatest rappers of all time. His versatility as a smooth lyricist, battle rapper, and conscious artist has managed to prolong his staying power over the years.

- **I think it's more that I struggled that I gained an appreciation for it.** The theme of needing intellectual stimulation and a challenge to do well

- **In terms of getting my homework done, I wasn't looking towards family at all.** The theme of a less than ideal home environment, despite the fact that Antonio's parents are college educated, hold advanced degrees, and are themselves educators. As a non-FGS, Antonio was still largely unable to "capitalize" on the cultural capital of his parents.

- **A bit of a cultural shock.** The theme of not fitting in and sensing a clear racial divide within various institutions and their respective cultures of STEM

- **Where's my time?** The theme of not finding racially similar mentors, help from administrators, or people who could relate. The theme of a lack of resources dedicated to issues important among diverse learners.

- **I felt there was a difference between me and the other classmates.** The theme of racial disparity and comfortability differences among White and Black students. A less than ideal fit for diverse learners is enhanced by a culture that caters towards the needs of White male students within STEM.

- **My biggest problem with the role of race…is the immediate identification.** The theme of being stereotyped according to race and being subjected to an unwelcoming environment before being seen as an individual

- **I think Hip Hop has played a role in my ability to dream wildly.** The motivational theme of inclusiveness, and the support found within Hip Hop culture

- **Just stick to your Dmitri Mendeleev.** The theme of the need for self-efficacy and within STEM (and Hip Hop), despite the obstacles of cost, difficulty, and lack of overall support within STEM programs

Antonio's emergent themes centered on a lack of fit between his style of learning and other non-Black students majoring in STEM, and consistently feeling like an outsider. Though he had some supports in place at home, he was largely unable to benefit from the college based cultural capital his family of educators with advanced degrees had managed to amass due to other familial stress factors. Instead, Antonio has attended multiple institutions without yet earning a STEM degree of any kind to show for his efforts—the financial burdens of earning a degree have been considerable due to financial setbacks arising once his mother became ill. Since attending private high school, Antonio has liked to think about deep subjects that stimulate his desire to learn more. This has allowed him to potentially envision applying his knowledge towards a technology based degree. However, similar to Dana, a lack of consistent mentorship and stability left Antonio feeling like an outsider at nearly every institution he attended. Though he did benefit from a first year program with extra supports and advising components build in, he did not find the same level of concern for his well-being at other campuses which did not necessarily cater to unique and diverse learners like Antonio. It has been the culture of Hip Hop, however, which has inspired his ability to "dream wildly" and to push forward. This has enabled

him to see himself in a meaningful STEM based career—even though other cultures within academe have been less than hospitable and often unwelcoming. Like William, Antonio immediately feels comfort emanating from within Hip Hop culture and from the practitioners of its various disciplines. He is yet to earn a college degree, but during his studies he found time to become certified in massage therapy to help pay his mounting bills. Despite all of this, Antonio still wishes to continue towards attainment in a rewarding STEM degree program. He considers a degree in educational technology, but after first getting a handle on his outstanding college loans and devising a realistic plan to finance the rest of his credits needed to graduate—potentially from UMass-Boston.

Lauryn. Lauryn's pseudonym is based upon her parents' favorite rapper—Lauryn Hill. Ms Hill's confident persona has been well chronicled in rap circles and reflects the confidence exuded by Lauryn throughout this study. Lauryn instantly commands respect, and likewise Ms. Hill's fierce rapping ability and versatile talents, both as a solo artist and as part of the legendary rap group *The Fugees*, have earned her the respect of millions.

- **I chose Northeastern because of the Ujima Scholar's Program, not because of what I majored in**. The theme of finances influencing her choice to come to the institution and major in a STEM discipline, not simply the reputation of the major or the school was at work with Lauryn. This sentiment of the importance of finances is supported in the literature and was also common among all of the other participants.

- **They're designed to weed students out and I don't like that.** The theme of being set up to fail in STEM coursework where "weeding-out" is a norm

- **I don't see a lot of faces that look like mine.** The theme of a lack of "diversity" as it pertains to Black and Latino faces, particularly women, except within the safe haven of

the Ujima program. Lauryn reiterates the theme of not belonging, and looking forward to returning to a more familiar culture for her graduate studies, which she plans to complete in the South.

- **I didn't really like the vibes here**. The theme of an unwelcoming cultural environment, and the divisive attitudes of many of the students within STEM majors

- **In psychology, it seems that people are more willing to help each other get ahead**. The theme of the cut-throat environment within STEM and the more welcoming cultures outside of STEM

- **The way that I learn as a Black person is somehow different from the way that European's standards of education have been formulated**. The theme of being perceived as different, yet without an appreciation for the inherent different learning styles across various races and cultures

- **Hip Hop has always been a voice for the voiceless**. The theme of Hip Hop as a social justice platform, as well as a welcoming positive culture and launching pad for URMs

Summary of the Narratives

Clearly, a great deal of overlap in terms of the themes revealed by each participant in the study was evidenced across the narratives. In agreement with the literature, themes of unwelcoming cultures within traditional higher education STEM based programs are exacerbated for URMs where race is an unescapable central factor. The participants of this study received well-rounded pre-college educations, with several opportunities provided to attend excellent institutions—many of them private schools. The families they emerged from all valued education; all participants had parents who were either accepted to a higher education institution, attended college or university, or were educators themselves who supported their children's

decisions to attend and graduate from a four year institution (thus rendering many of them as not FGS in nature). All of these benefits, however, did not fully prepare them for the less than enjoyable experiences they had as undergraduates at various elite institutions where racism and low-expectations still found room to maneuver and operate around various bridge programs and other support structures—specifically in place for URMs. This point is also reflected in the literature review where cultures of institutions often do not match the climate lurking in various classrooms or departments. Though all participants had either preparatory collegiate schooling or were part of a supportive program for at least a portion of their freshman year in college, they still chose to leave their intended STEM majors to pursue more welcoming degree options within other programs of study.

Lauryn's themes were common with those of Dana, William, and Antonio—where all experienced unwelcoming atmospheres in STEM, which seemed more exclusive than inclusive. Like Dana and William, Lauryn found that her collegiate STEM programming seemed to be setting her up to fail and was designed to remove URMs from STEM majors—not to retain them. Lauryn was well prepared in her private school pre-collegiate experiences in similar fashion to Antonio and William. She also recognized, like Antonio, a distinct difference in the way Black and White students benefitted in terms of learning styles; this reality was also underappreciated by most faculty and staff members. Lauryn left her behavioral neuroscience major, which was also preparing her for a pre-med degree, to focus on earning her psychology degree from Northeastern. Her reasons mirrored Dana's rationale for leaving her science based pre-med STEM program to instead major in sociology. The lack of diversity within STEM was a theme Lauryn had in common with all members of the study. Lauryn, like William, recognized the inclusivity of Hip Hop culture as a potential remedy if properly incorporated into STEM studies.

In order to emphasize these points and to help more succinctly articulate how the later rounds of coding showed cross-thematic similarities among the participants, this researcher wrote a sixteen bar rap verse which merges these ideas, while also demonstrating the usefulness of Hip Hop lyrics as a constructive learning tool. The creation of the verse also embraces the desire of the participants to have educators incorporate Hip Hop culture and lyricism within more traditional pedagogical approaches to education. The following represents a synthesis of the findings in the tradition of classic Hip Hop lyricism, with approximately four bars each dedicated to the most emotionally conveyed theme by each participant in the study.

Sit in your classes which I ain't passing proficiently/

Misery, in other words time ain't passing efficiently/

This degree—I'm chasing for what? If you can't envision me/

As someone who'll eventually work in the STEM industry/

If you won't mentor me, plus you've been thinking less of me/

Attrition is the mission you're whipping up as a recipe/

I got some friends with me, telling me it's more welcoming/

And culturally accepting, Professors acting like gentlemen/

In other majors, plus ladies are more visible/

As faculty and students, and nobody's quite as miserable/

Nobody tricking you, weeding you out intentionally/

Where racially, at least, we're in the mix-motivationally/

Speaking in peer groups, where people don't fear you/

Cause in my STEM classes, I felt like it was weird to/

Speak about the things, and the way, I like to speak/

And keep it Hip Hop, with my Squad if they all ain't Geeks

Findings in Relation to the Research Questions

The central research question for this study was "Which factors do URM students who have left STEM degree programs feel played the most significant roles leading to their own attrition?" Overwhelmingly, the most prevalent answer was an unwelcoming STEM culture in general, which was only exacerbated for URMs. A lack of a positive mentor and support system within STEM was another factor cited by participants who left their respective majors, while those who had any kind of a supportive figure or support structure in STEM (or elsewhere) mentioned it as the reason they persisted as long as they did within the given institution. Though various supports were in place to help these URMs succeed during their college careers, many of them were largely ineffective due to not being specifically designed with emphasis placed upon helping URMs succeed within STEM based majors.

The supporting question for this study was: How do URM students feel STEM education in higher education institutions could be conducted more effectively to reach and retain URM students? The central theme pertinent to this issue was the prevalence of a detrimental weeding-out process that attempts to intentionally fail a certain number of students which the programs never intended to keep in the first place. The desire to eliminate this "designed to fail" attitude was common among the participants, whom all stated feeling as if they were being "set up" for imminent failure reinforced by low-expectations of African Americans to persist in STEM. The lack of access to caring STEM faculty or staff members with the potential to understand the participant's perspectives, or to serve as mentors, tutors, or role-models was consistent across the study. All of the participants readily observed these sorts of supports outside of STEM majors, thus making a switch of majors more appealing.

Lastly, this study sought to understand what role could the infusion of elements from Hip Hop culture into various aspects of higher education play in potentially alleviating the issue of attrition for URMs majoring in STEM disciplines? The participants answered based on their own familiarity with Hip Hop culture, and rap music in particular, and all expressed favorable attitudes when asked about the potential incorporation of Hip Hop into STEM programs. Answers given reflected the ease of which participants could recall Hip Hop lyrics years after first hearing them, yet often would quickly forget rote formula drills aimed at memorization of difficult concepts and vocabulary inherent within STEM disciplines. One participant revealed his own "weeding-out process" for determining the prospectus of other students becoming his friend was based on whether or not they were "down with Hip Hop culture." Other members cited the intense love they have had for Hip Hop music since their childhood years and how inclusive the culture is by nature—and the inherent respect for Black culture found within it.

Dana cited her ability to remember rap song lyrics verbatim decades after hearing them, and questioned why Hip Hop could not be utilized in similar ways as pedagogical tools that educators could use to help students memorize detailed material. However, she found STEM and Hip Hop to be extremely disconnected in her college experience; with the exception of social events or within student groups, its power was never actualized. Lauryn likened the grit required to do well in a demanding STEM program as analogous to the same determination and resolve to succeed in the rap music industry against all odds; Antonio and William also recognized the required grit to do well in both STEM and the Hip Hop industry. Antonio saw similarity in the concepts of exponential growth as a potential entry point for STEM educators. He likened the amazing progress made in Hip Hop in such a short time since its inception, from humble beginnings to a global phenomenon, as comparable to the rapid and "exponential" advances we

have made across STEM content areas such as space exploration and navigation. Finally, a

portion of William's reply to the final interview question exemplifies the overall positive attitude

the participants expressed towards the usefulness of Hip Hop within academia as a means to

advance STEM.

> In our STEM classrooms we need to use the spirit of Hip hop to inspire, creativity, out-
> of-the-box-thinking and an inquisitive spirit that is unquenchable. We need to inspire the
> next generation to think of more questions and not try to have an answer for everything.
> Campuses should stimulate exploration and search for the unknown rather than hiding the
> unknown behind the "we've always done it this way."

Implications for STEM Practitioners

Instructors of required courses for STEM majors ought to seek out ways to engage URMs

since these students often feel uninspired, unengaged, underappreciated, and less than welcome

in their STEM based classrooms (Gasiewski et al., 2012). These factors played a more

significant role in this study than any lack of ability due to inadequate college preparation.

Though cultural capital is often reported as lacking among URM students, the students in this

study were not necessarily derailed due to a lack of familiarity with the culture of higher

education or inadequate pre-college experiences. Rather, most left of their own volition after

sensing climates that were hostile for minorities or non-inclusive with regards to multiple

learning styles or the incorporation of cultural elements commonly found favorable among URM

populations. This is very telling, especially when the suggestions emanating from many studies

reviewed in the literature simply call for more programs and mentorship opportunities. Clearly

this is not enough, when strongly prepared students in this study had many of those suggestions

in place as well. In fact, once many of these programs were removed, students seemed to expect

these types of experiences would be consistent throughout their college experiences—when in fact they were the exception. What seems to be evident is a need for STEM departments and educators to recognize that regardless of the programs students may or may not have had the good fortune to experience for a portion of their academic careers, this still may not be enough to counteract the hostile climates URMs often experience throughout the duration of their STEM educations. Developing, implementing, and continuing these sorts of innovative programs and supports ought to be the norm—rather than token exceptions.

STEM Educators would be wise to find intersections of Hip Hop culture and STEM to enrich their courses, since the global phenomenon of Hip Hop culture is widely appreciated by URMs and non-URMs alike. This study affirms the claim of various researchers that if educators wish to engage URM students on PWI campuses there is perhaps no greater potential vehicle available than simply attempting to better understand the culture of Hip Hop and including it via curricula or pedagogically within their lessons as cultural validation (Emdin, 2010; Emdin, 2011; Hill, 2009; Petchauer, 2010; Hill & Petchauer, 2013; Stovall, 2006). Unanimous consensus supporting the incorporation of Hip Hop culture (thus STEAM) into the prevailing culture of STEM was evidenced by the participants in this study. Participants all revealed considerable knowledge regarding Hip Hop and an understanding of how it has served at its most basic level as a memorization tool—and in a larger context as a cultural bridge and social reform platform. The grit and self-efficacy required to persist in both STEM and Hip Hop was a point made by several of the participants in the study as well.

Implications for Higher Education and STEM Based Industries

Colleges and universities are already richly infused with examples of Hip Hop influencing the campus culture, yet this culture is often ignored within STEM classrooms

(Emdin, 2011). Campus leadership would be advised to intentionally find ways to embrace the culture and global phenomenon of Hip Hop as a recruitment and attainment initiative which speaks clearly to URM students as an effort to be more inclusive and conscious of the needs of its most diverse learners. This, however, should not simply be a one-time event, such as bringing a rap artist to campus to perform at an orientation or end of the year concert. This idea is shared in the words of Ladson-Billings (2014), "The idea that adding some books about people of color, having a classroom Kwanza celebration, or posting "diverse" images makes one "culturally relevant" seem to be what the pedagogy has been reduced to" (p. 82). Capable students with more than enough pre-collegiate preparation are leaving STEM majors festering within unwelcoming classroom cultures, often conducive to breeding hostile conditions, which repeatedly fail to embrace the kinds of diversity valuable URMs bring to campus. Campus hiring practices should reflect these considerations. This would help to provide more classroom educators, researchers, and staff, all cognizant of the power of Hip Hop culture (introduced into STEM as STEAM), with a powerful deterrent towards the potential attrition of its URM students.

Congress mandated several decades earlier that the NSF ought to find creative ways to increase URM student's chances at STEM degree attainment help counterbalance a host of circumstances working against them (Lansquiot, Blake, Liou-Mark, & Dreyfus, 2011). More recently, a report based on a study by was prepared for the NSF that concluded only 34% of Black students initially declaring a STEM major went on to attain a STEM based degree compared to 61% of Whites (Elliot et al., 2012). The US President's Council of Advisors on Science and Technology (PCAST, 2012) even more recently predicted 1,000,000 more STEM graduates were required over the next decade to approximate US workplace demands. Much of this shortage results from the low percentage (40%) of incoming college freshman seeking to

earn a STEM degree, while managing to only retain 40% of those students as well (PCAST, 2012). As a matter of national security and economic stability, helping colleges and universities graduate more URMs in STEM should be treated as a priority by competent systems level leaders. All of the members of this study had support structures in place at some point in their college careers, and all of them had private school educations or attended otherwise fine academic public schools. All of the students were also involved in some sort of supportive college program in their first year which sought to make college acclamation an easier process, with focus on improving URM success in higher education—yet none attained a STEM degree. However, these students were not part of any support group that held a similar goal while also being especially designed to support URMs in STEM. This study highlights many of the areas in which academia could creatively improve its delivery system of STEM content, while helping to cultivate and redefine best practices among STEM educators and their institutions who are committed towards increasing the acquisition of social and cultural capital for its most marginalized members. This underscores the importance of how the sciences should not be in competition with the arts—rather their disciplines ought to be merged through creative STEAM initiatives like those proposed in this study.

Recommendations for Future Research

As stated earlier, no true definition of STEM actually exists. Though the NSF has included a great wealth of majors it considers to be inclusive within STEM, the reality is that colleges and universities are free to determine what is considered a STEM major. While degrees clearly rooted in science, technology, engineering or mathematics are of course aptly considered STEM, it becomes far more questionable what STEM *is* when fringe disciplines are considered. For instance, the NSF includes psychology within its ranks of what it considers STEM, however

none of the students in this study were aware of this fact. The implications here are potentially confounding when reports are produced which claim higher retention in STEM than otherwise would have been reported had majors like psychology, which URM STEM majors often switch into, had *not* been counted. If one college considers a certain major as STEM and another does not, statistics on STEM degree attainment, persistence, or attrition may be less reliable and meaningful without more consistency.

Clearly, students like Dana and Lauryn were enrolled in traditional core science curriculums during their first two years, but later were turned off by the culture and climate of these majors and switched to more "warm" disciplines (sociology and psychology respectively) instead. Further, both participants used terms of "pre-med" for the major programs they were pursuing. Yet, the NSF also does NOT consider pre-med as a STEM major—even though these types of degree programs, or tracks, are commonly filled with precisely all of the kinds of traditional hard science courses that one would most assuredly consider STEM. This is likely due to the fact that many colleges and universities (including those attended by participants in this study) do not actually consider "pre-med" as a major, rather it is more typically a reference to science based courses one would need to have successfully completed in order to enhance one's chances at being later accepted into medical school. In certain institutions, it is possible that students who were in some sort of general science program while under an umbrella of "pre-med" may not have been included in attrition statistics if they later left the major—since the NSF would never have considered them in a STEM major in the first place. This would be a worthy study in its own right.

Investigating these nuanced STEM definition issues throughout this study has alerted this researcher to the fact that many studies which use an NSF definition of STEM would then seem

to lose less URMs out of STEM if similar definitions were maintained across all such studies and institutions. This implies that the results of URM degree attainment in what many traditionally consider STEM is likely far lower than what has been reported in previous studies. This only exacerbates the pressing need for traditional STEM degree programs to view its URMs as highly coveted students who cannot afford to be lost to other more "welcoming" majors. Though this study did not consider psychology majors as traditional STEM disciplines, it would be relevant to undertake a future study that looks into this potential discrepancy to ascertain if STEM attainment and attrition numbers would be significantly impacted.

Limitations of this Study

This study does not assume that every URM student will be a fan of Hip Hop, let alone be experts on its inclusive and embracing culture. Cultural capital levels are hard to predict for incoming students and therefore no assumptions may be made on which lessons students need to extract from the culture of STEM and higher education in general. Yet, the process of acquiring social and cultural capital, needs to continually occur even if URMs are arriving on campus with increasingly greater nuanced understandings of what is necessary to succeed in academia and within STEM majors. Mentors and human relationships are not always able to be planned. Regardless, the infusion of caring personalities within STEM disciplines which lend themselves towards organic human interaction with students ought to be a consideration for any STEM department looking to retain more of its students.

A small sample size of participants, of course, does not necessarily imply similar findings will occur in future studies or be replicable across all campuses. URMs currently residing in other parts of the country were not interviewed in this study. Perhaps this could occur as a recommendation for further studies to determine if campus climates where perceived as "chilly"

as they were by three out of the four participants in this study—all of whom attended competitive East Coast institutions often characterized as "fast-paced" and "unyielding."

Respondent bias may have also been a factor in this study. Those participants who ultimately responded may have consisted of those who were not as academically "weak" as others not persisting due to other factors such as lower pre-collegiate preparation. It is possible that those who did respond may have had stronger emotional feelings regarding their unwelcoming experiences, and perhaps felt more compelled to share their stories.

Each participant in this study was approximately five to ten years younger than the next closest participant and resulted in a similar spread in terms of first year of attendance. This was not designed, but the study could have been controlled to only include students who have "recently" concluded their studies in STEM—if so desired—to evaluate "current" attainment issues for URMs in STEM. A strength of this study, conversely, was that it did allow for a continuum of issues to be perceived over a span of 20 years of college, where strong problematic themes were still evidenced despite claims that institutions have been trying to do more to recruit and retain URMs in STEM. A final potential limitation of this study was that despite the fact that the definition of URMs in STEM also includes Latinos, Native Americans, and Pacific Islanders, only African Americans responded to the recruitment letters sent out for this study.

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Appendix A

Letter of Introduction

Dear potential participant,

My name is Peter Plourde, I am a doctoral student at Northeastern University majoring in education (concentrating in Higher Education). I am a full-time faculty member at Northeastern University where I teach mathematics within the Foundation Year program in the College of Professional Studies. I am interested in interviewing members of underrepresented minority (URM) populations who previously majored in science, technology, engineering, and mathematics (STEM), but did not ultimately complete a degree in a STEM major.

My study seeks to better understand why so many URM students majoring in STEM disciplines at predominantly white institutions do not end up graduating with a STEM based degree. As a published rap recording artist since my childhood (professionally known as Professor Lyrical), I also wish to examine the cultural experiences of URM students initially enrolled in STEM degree programs who also identify with the culture of Hip Hop in order to ascertain the perceived usefulness of including elements from Hip Hop culture into STEM classrooms and/or the campus as a whole. I am hoping you wouldn't mind being interviewed directly by me, for no more than 90 minutes, concerning your experiences as a former STEM major in order to help ultimately increase the rates of degree attainment for URMs in STEM. Please respond to this email only if you wish to be considered for the study.

Thank you for your time and interest,

Peter Plourde
Plourde.p@neu.edu
Northeastern University

Appendix B

Research Questions

Interview Protocol:

Tell me about yourself and why you chose to originally pursue a STEM degree? For purposes of

this interview, we are defining STEM as the acronym for science, technology, engineering, and

mathematics and those disciplines of study containing these categories of knowledge.

What were your experiences with STEM and STEM courses before starting college?

How adequately did your high school prepare you for majoring in a STEM discipline?

Why did you choose [insert name of school]'s STEM program?

How would you describe the level of diversity at [insert name of school]?

How would you describe the level of diversity within your STEM program?

When you first started with the program what did you expect the experience to be like?

What surprised you the most about your experience in the STEM program?

What disappointed you the most about your experience in the program?

What did you like most about your experience in the program?

What supports did you have available to you to help you with your coursework? How helpful

were these supports?

What supports did you have available to help you with college/university life in general? How

helpful were these supports?

What factor/factors do you feel were most important which led to your attrition from STEM?

-If answer to above involved a switch of school ask: What was the major and school you

switched into, and have you completed your studies or when are you likely to do so?

-If answer above involved a switch of school or program ask: How would you describe your level of involvement with your peers and/or faculty both in and out of the classroom in your new program?

-If student switched into a new major and/or changed institutions ask: How would you compare or contrast the culture and climate of your STEM major with that of your new major?

What could have been done to keep you at [insert name of school] in a STEM major?

What role has raced played in your experience as a STEM major at [insert name of school]? Do you feel it played a factor in your eventual attrition and change of [school and/or major]?

Has the culture of Hip Hop been a factor in your life outside of school, and if so how?

-If student is not aware of the cultural components of Hip Hop researcher will provide further prompts by explaining the core four elements of the culture and the additional principal elements as necessary.

Has Hip Hop culture been a visible part of the campus culture during your academic career? If so how?

In what ways are the cultures of Hip Hop and the culture of STEM at [insert name of school] similar or different?

In what ways might the elements of Hip Hop culture be incorporated into STEM classrooms or campus culture in general?

Affirm what they shared.

Reflect back to them what they have said.

Appendix C

Unsigned Informed Consent Document

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**Northeastern University, College of Professional Studies, Education Department**

**Name of Investigator(s):** Dr. Kelly Conn, Principal Investigator; Peter M. Plourde, Student Researcher

**Title of Project:** *Increasing STEM Degree Attainment For Underrepresented Populations*

**Informed Consent to Participate in a Research Study**
We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

**Why am I being asked to take part in this research study?**
You are being recruited for this study which is investigating members of underrepresented minority (URM) populations (Black, Latino, or Native American) who have previously majored in a science, technology, engineering, or mathematics (STEM) major but did not persist to attainment of a degree in a STEM major.

**Why is this research study being done?**
This study will be conducted with the purpose of attempting to figure out how students might be better served within higher education classrooms and campuses to ensure greater numbers successfully graduate as STEM majors.

**What will I be asked to do?**
If you decide to take part in this study, we will ask you to answer interview based questions with the student researcher about your experience as a STEM major and what aspects of your experience were helpful or harmful. The following is a small excerpt from the interview questionnaire:

*What were your experiences with STEM and STEM courses before starting college?*
*How adequately did your high school prepare you for majoring in a STEM discipline?*
*Why did you choose [insert name of school]'s STEM program?*
*How would you describe the level of diversity at [insert name of school]?*
*How would you describe the level of diversity within your STEM program?*
*When you first started with the program what did you expect the experience to be like?*
*What surprised you the most about your experience in the STEM program?*
*What disappointed you the most about your experience in the program?*
*What did you like most about your experience in the program?*
*What supports did you have available to you to help you with your coursework?*
*How helpful were these supports?*

**Where will this take place and how much of my time will it take?**
Participants will meet once to answer interview questions in a session which will not exceed 90 minutes. The location will be chosen by you the participant. Participants will be followed up with by email in an effort to share information from the preliminary data with the participants to clarify and potential misinterpretations. They will be asked to provide specific input if there is a need for any correction.

**Will there be any risk or discomfort to me?**

There will be no risks or discomfort associated with this interview. If for any reason you choose not to answer a question you are under no obligation to do so.

**Will I benefit by being in this research?**
The information learned from this study will be shared with the participants and may help other policy makers, educators, and administrators better address the lack of URM students successfully earning STEM degrees and entering the STEM workforce, as well as inform stakeholders of how to recruit and retain this same population in higher education in general.

**Who will see the information about me?**
The participant's identity WILL NOT be matched to their responses. Only the researchers on this study     will see the information about you. No reports or publications will use information that can identify you in any way or any individual as being of this project.

Participants will only be identified as "former students of STEM based majors" at a given area institution type (such as large or small school for example) and will be given pseudonyms as needed.

No specific names will be utilized in the study, and any identifiable information gathered or recorded during all interviews will be categorically removed from transcription of these interviews.

Any digital recordings or data will be destroyed at the conclusion of the research process. These interviews will be digitally recorded, transcribed and coded. Data will be stored in paper form (and on a digital recorder) in a locked file cabinet, and a password protected laptop computer. All digital recordings and digital and/or handwritten transcriptions of data will be destroyed at the conclusion of the research process.

In rare instances, authorized people may request to see research information about you and other people in this study. This is done only to be sure that the research is done properly. We would only permit people who are authorized by organizations such as the Northeastern University Institutional Review Board to see this information.

**What will happen if I suffer any harm from this research?**
There are no physical risks associated with this study.

**Can I stop my participation in this study?**
Your participation in this research is completely voluntary. You do not have to participate if you do not want to and you can refuse to answer any question. Even if you begin the study, you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services that you would otherwise have [as a student, employee, etc.].

**Who can I contact if I have questions or problems?**
If you have any questions about this study, please feel free to contact Peter Plourde, the person    mainly responsible for the research, at *140 Jaques Street, Unit C, Somerville, MA 02145, Email: plourde.p@neu.edu, Phone: 617-331-5790.* You can also contact*, Dr. Kelly Conn, the Principal Investigator at College of Professional Studies, Northeastern University, 20 BV 360 Huntington Avenue Boston, MA 02115 Email: k.conn@neu.edu, Phone: 857-205-9585*

**Who can I contact about my rights as a participant?**
If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish. If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research

Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

**Will I be paid for my participation?**
No

**Will it cost me anything to participate?**
No

**Is there anything else I need to know?**
You must be 18 years of age to participate in this study. The student investigator is also a current Northeastern/Foundation Year faculty member teaching mathematics. He has been with Foundation Year since its second year (Cohort II, 2010-2011 school year).

_____
**Signature of person agreeing to take part**                                               **Date**


_____
**Printed name of person above**


_____ _____
**Signature of person who explained the study to the**                                **Date**
**Participant above and obtained consent**


**Printed name of person above**