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Consequences of Stereotype Threat and Imposter Syndrome: The Personal Journey from STEM-Practitioner to STEM-educator for Four Women of Color

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Consequences of Stereotype Threat and Imposter Syndrome

The Personal Journey from STEM-Practitioner to STEM-educator for Four Women of Color

Kristina Henry Collins, Erica F. Price, Lisa Hanson, & Dianne Neaves

Abstract

This article highlights the STEM journey of four women of color that matriculated at four different types of universities (R1, PWI; HBCU; private, religious-based PWI; and an international HSI university) for their undergraduate STEM degrees. The ethnographical narratives shared by each, informed lessons learned about stereotype threat, imposter phenomenon, and the chilly environment that is present within male dominated STEM fields. The authors offer recommendations to reduce the consequences of these issues to include deliberate STEM identity development and STEM mentoring. Framed by the CLIC (content learning and identity construction) theoretical framework and Collins' (2018) Black student STEM Identity model (BSSI), vertical mentoring and service-learning best practices are discussed along with initial results of a pilot study designed to address these issues.

Introduction

Women and minorities in America continue to be a very underutilized source

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of human capital in science, technology, engineering and mathematics (STEM). There is an overall low concentration of both subgroups in STEM relative to the number of women and minorities in the overall workforce and that hold STEM degrees. Whether categorized by workforce or STEM degrees, non-Hispanic white males make up the majority of individuals identified as scientists or engineers (The National Science Foundation & National Science Board, 2020). NSB's 2020 science & engineering indicators showed that while in the last twenty five years women's presence in the broad area of science and engineering has significantly increased by degrees and within the workforce, the enormous disparity between men and women has shown insignificant improvements: Marked by the year that the first of these four featured women received her undergraduate STEM degree, in 1993 working women earned 43% of all college degrees and represented 31% of individuals with doctoral, science and engineering degrees that were hired in the field. Yet, disproportionately, they represented only 23% of the overall science and engineering field workforce. In 2017, working women earned 52% of all college degrees and accounted for 45% of those with doctoral degrees in science and engineering, but still represented only 29% of those working directly in engineering and science fields. Researchers have attributed this to complex factors in the science and engineering discipline that include gender discrimination, disparity in grant funding and opportunities, and inequity in scholarly manuscript reviewing (Ceci & Williams, 2011; Hoppe et al., 2019).

The common discussion surrounding these facts and possible solutions are not new, but our last point compels another question that is oftentimes not addressed in terms of implications and a discussion for possible solutions: Where do these college-educated STEM women go when they do not persist in the fields of science and engineering? How do they cope with those reported complex factors that deter them from building a career in their preferred area of study, and deny them of being who they are in terms of academic identity—a scientist or an engineer? Possible answers to these questions are outlined in this article by four women of color who provide personal narratives of coping and survival in their journey to realize their dreams of becoming scientists and engineers. Their STEM stories reveal accounts of stereotype threat (Steele & Aronson, 1995), imposter syndrome/ imposter phenomenon (Clance & Imes, 1978), and a “chilly climate” within a white male-dominated field (Sandler, 2009). They represent different geographical backgrounds, and were all educated in different types of universities for their undergraduate STEM degrees: A Research Institution (R1), a historically Black college and university (HBCU), a non-continental state institution and a foreign private institution. All four of them have master's degrees and two of them have pursued doctoral degrees. While the paths to their current careers are different, they shared a common journey from STEM practitioner to STEM educator. Each of them in their separate STEM struggle and decision to leave the direct STEM field, found ways to stay connected to who they are and what they loved

most—science and engineering. Today you will find them in higher education researching STEM identity and talent development, teaching undergraduates in natural science, mentoring K-12 instructional coaches as a STEM curriculum director, and teaching elementary students 21 century STEM skills. Sharing stories from different stages of their life, these are their STEM stories. While each person is not explicitly identified in her different story, the reader will recognize similar struggles that are commonplace for women of color no matter their geographical background, educational setting, and STEM major.

Early Signs of Imposter Syndrome in and Out of the Classroom

Reflecting on my own STEM talent development—while not conceptualized as such at that time—I now realize that my own STEM interest and academic motivation was unintentionally influenced early in my life as a result of the activities that my mother facilitated within the home. It was unintentional in that most of the home-based activities were not implemented with the goal to build STEM skills, but rather to compensate for inability to pay for extra-curricular activities, to keep me busy as an only child at the time, and creative ways to incorporate day-to-day chores while entertaining me as a child. Unintentional as it was, I spent my most memorable childhood moments sitting at the kitchen table with my mom and step-dad fixing puzzles, playing board games, solving logic puzzles, mathematically adapting recipes, and trying to understand diagrams from the many auto mechanics books owned by my step-dad. The kitchen table became my STEM playground where many hours of informal, culturally relevant learning and critical thinking experiences became the central theme of everyday activities. It was these experiences that largely influenced and fostered an intrinsic value, interest, and academic success in STEM. As a matter of fact, I had mastered the game of chess by the age of three and by the time I was a pre-teen, I could take a technical manual of any kind, make sense of its complicated diagrams, and effectively communicate instructions to anyone wanting to build something. Outside of the “protection” of guiding parents, my development as a STEM student was at best, socially adverse.

In the classic sense of the term, I experienced imposter syndrome in the classroom as early as high school, often being the only person of color and the youngest in an accelerated, advanced mathematics and computer science curriculum. I didn't take the male-dominated auto-shop class nor did my female friends find studying technical manuals a “girlie” thing to do. The more advanced courses became, the less I would see students that I associated with socially or who looked like me. I started to wonder why the friends that I had the most in common with socially were not in these classes with me. Even though I continued to build on my STEM skills throughout my young adult life, I often found myself feeling as if I wasn't ‘one of them.’ For example, even though I considered myself good at “doing”

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mathematics, I did not see myself “being” a mathematician or computer scientist. On the flip side, I experienced imposter syndrome outside the class as well – I wasn’t ‘one of them’ either. I later referred to this as “superman syndrome”, having extraordinary talents but hiding them to fit in. In high school, I would even go so far as to hide the fact that I was in the most advanced “nerd” classes. I would often downplay my intelligence using humor. Based solely on these early experiences, I would proclaim that one consequence of imposter syndrome and stereotype threat for women of color is feeling as if they are living a double life, and not wholly true or belonging to either.

As I remember, I chose my undergraduate degree and the college that I attended based on a single conversation that my AP calculus teacher had with me. She (white female) told me that I should go into engineering because, as a Black female, it could be the “ticket out” of my small town in Alabama. When deciding where I would go to college, I chose the same R1, predominantly White Institution (PWI) that she attended. I knew nothing about engineering or college, but applied only to that school and entered with a declared major in engineering. As a first-generation college student, even new student orientation was intimidating. Again, I looked around at peers and doubted my abilities, marginalized my intelligence, and determined that I did not belong. Constantly, in every new phase or venture, I think that there was no way that I could accomplish what others have. In typical imposter syndrome fashion, I attributed my success to luck and my failures to not being equipped to succeed. So much so, that at the beginning of the first semester in college, I signed up for the military; it was the “backup” plan and previously, the only other option I had considered. After a dismal first semester, I left college. Interestingly enough, my ASVAB (Armed Services Vocational Aptitude Battery) scores were so high that I was able to pursue one of the most highly classified and technical positions available for enlisted, female recruits – cryptologic technician collector (CTR), a component of the military intelligence program. I enjoyed my job in the military and was afforded an opportunity to return to college while fulfilling my military commitments through the Sea & Air Mariner (SAM) program. However, there were two times that I attempted to switch my military job. Once I inquired about an opportunity to work on a submarine. Another time, I attempted to transfer into an officer program within military intelligence. In both cases, I was met with gender-based limitations and stereotype threat. I remember sitting across three white males during my officer candidate interview and at one point listening to them debate about one inappropriately questioning my marital status and parent status. Similarly, during my senior engineering seminar, my professor advised me and the only other female in my cohort to not to wear a ring to interviews because, for females, it signaled potential maternity leave, family priorities, etc. Yet, for males, it took on a positive meaning of stability. I earned my bachelor’s degree in electrical engineering technology (EET), and worked in the field for six years while serving in the military.

My initial plans were to go to graduate school for engineering. When speaking to a counselor at the same university, I was told that my transcript did not reflect a strong mathematical background. So, I returned home to attend a regional institution to take math courses to enhance my transcripts. For registration purposes, I pursued a master of science in education with a concentration in mathematics. I taught developmental mathematics and basic algebra courses for the mathematics department and worked as a substitute teacher. After substituting for the high school computer science class one week, I received very positive feedback from students and parents. This impressed school administration enough to ask me to apply for a permanent position as the computer science teacher. Before even finishing my master's degree, I transitioned into teaching with a provisional teaching license based on my STEM background and experiences.

My transition from STEM practitioner to STEM educator was not particularly planned or strategic; it came from the challenges and/or decisions not to persist in one area that led to other opportunities. Subsequently, I have integrated a STEM discipline at every level of my career and for each of my advanced degrees, submitting to the one thing I knew to be true—I am most fulfilled and engaged when the task is related to STEM. As a high school computer science, integrated technology, and mathematics teacher, I drew from my own STEM experiences to inform my teaching philosophy and practices. I recognized the importance of mentoring and guidance for these students through the STEM pipeline. Yet, even as I successfully built a career and fostered STEM identity and talent development for students that came from the same background as me, I still found myself struggling with the imposter syndrome. While pursuing my Ph.D. in educational psychology, I added quantitative research methods (QRM) as my minor study. Studying advanced statistics, more times than not, I was the only Black person in the class. I was one, among a scarce number of White students and dominated by Asian students and professors. Again, the stereotypes proliferated and I felt lost, confused, and out of place. Even after earning all A's in every QRM class, I must admit that I initially questioned the validity of those grades compared to my perceived skill set.

Imposter Syndrome still creeps in, as a junior faculty in higher education undergoing the tenure and promotion process, feeling the stress of publication requirements, and battling perceived isolation as an underrepresented professional in my department, college, university campus, and field of study. To me, it is much like an addiction that you deal with one day at a time with self-affirming talks -today I feel empowered; today I made a difference; today I am worthy; today I have something to offer; today I can do this. Serving and mentoring students, especially underrepresented students in STEM, have reciprocal benefits. There is empowerment in the process of helping others to at least strive for higher education. It gives me a sense of purpose and inspiration to continue my own pursuits.

STEM Identity Threatened by Implanted Imposter Syndrome

The earliest memory I have of my profound interest in science and math is second grade. My teacher, an African American woman, taught us our multiplication facts using flashcards that we turned into bracelets. We wore them with pride. However, in sixth grade, I remember standing too long at the chalkboard to work a long division problem, and having my confidence shattered in one instant as my teacher—also an African American woman—yelled and instructed me to “SIT DOWN!” She proclaimed that I’d never be able to do math. I believed *her!* That one moment instilled in me a fear of risk-taking. My intrigue and desire to master mathematics was thwarted with a paralysis induced by her words. I had internalized the identity (or lack thereof) that she had spoken into my life. Even as I encountered several memorable math teachers in later years, I harbored a mental block for math. My love for the questioning, wondering why things were, and my natural inquisitiveness were still burning to be satiated.

The courses I selected in high school were challenging, and I excelled—I even graduated in the top five percent of my graduating class. I didn’t believe that I was one of the ‘smart ones’ who should choose math or science as a career choice, but something in me pushed me along that path anyway. During my senior year of high school, I had not decided on a college major, but I applied and was accepted into a summer engineering program for graduating seniors at one of the most renowned HBCU’s in the southeastern part of the country. My sister was there as a sophomore majoring in electrical engineering at the time, so I thought I would go to at least spend time with her. I enjoyed the classes, and the people I met. Still, it was still intimidating for me to be in that program with so many others who had attended schools with a pre-determined focus and preparation in pre-engineering. Oftentimes, I felt like an imposter ‘knowing’ that I wasn’t really good at math even though I had graduated high school ranked as number 11 out of more than 250 students and I had successfully earned high marks in all of the AP courses I had taken. I could visualize them as scientists and engineers, but I did not see the same in myself.

I proudly left the summer program with college credits on my high school transcript and excitement for my first full semester as a college student. Even though I was accepted, I was not going to attend that school. The financial strain on my parents to pay the high cost of attending an HBCU for my sister and me would have been too much. I accepted a full, presidential, academic scholarship offer from Lakeview State University (pseudonym), a different HBCU located in a more southern part of the country. Having never heard of LVSU and with no established support system in another state, I packed all the clothes (and my self-doubt) in the back of a Buick Regal for a journey with my parents across the country; it seemed like the longest trip of my life. I began a chemical engineering major influenced by my summer experience and love for science. I wanted to

study science, but I also wanted to help others. Engineering, as I saw it, didn't seem to do that directly so I changed my course of study to biology with a goal to enroll in pharmacy school after graduation. I knew of a lady from my church whose was a pharmacist—and she represented the epitome of helping others. She even helped me to obtain an internship as a pharmacy technician that I thoroughly enjoyed.

To pursue a Bachelor of Science degree in biology at LVSU, it was required to also minor in chemistry. Organic chemistry, genetics, and some of my upper level science classes almost broke me! The coursework was overwhelmingly challenging, and sometimes I considered changing my major to literature to feed my pastime passion—reading! I frequently studied with other natural science majors and engineering students to prepare for exams, tests, etc. In these study groups, I often wondered what my peers knew or had inside them that made the subject matter so much easier for them to grasp. Were they simply smarter? Did they have better study habits? Were they supposed to be there and perhaps I wasn't? I never shared my feelings of insecurity because everyone else seemed to have it together, and I didn't want to be “found out.” Reflecting back on that time, I realize now that I was no less intelligent than my peers and attending a HBCU provided an environment to feel racially secure. Within four years, I graduated with a Bachelor's of Science in Biology, and a minor in chemistry. I was the third person (and first generation at that time) in my family to graduate with a science or engineering degree—my sister earned her engineering degree two years prior and my one of my first cousins did as well at a different institution. I felt proud of my accomplishment.

After graduation, I immediately began working on my master's degree in chemistry at LVSU while I applied and studied for the PCAT (pharmacy college admissions test). I also worked as a substitute teacher to make ends meet. I enjoyed my work as a teacher—the lifelong desire to help others was satisfied! Consequently, I convinced myself that I would not pass the PCAT, and therefore would not be admitted into pharmacy school. The voices of self-doubt that I listened to and trusted since sixth grade told me I wasn't the pharmacist-type anyway. I decided, without any consultation or mentoring from anyone, I would commit to helping young people find their way toward a love of science instead. I became a science teacher and loved it! My experiences as science educator and school administrator have included middle school science teacher, chemistry teacher, high school science department chair, middle school assistant principal, elementary school principal, and master teacher and curriculum developer for a university-K12 partnership. I am currently the director of STEM curriculum for a fast-growing school district in the state of Texas and completing (ABD) my doctoral degree in curriculum and instruction

I took a path that moved me out of the direct STEM pipeline, but I have multiplied myself for the STEM field as a role model and mentor for others who needed me to show them that they are smart enough and good enough to pursue a

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STEM career or whatever their hearts desired. My love of science, my ability to connect with kids, and my skill set to deliver the content in a manner that made every student feel as if they too are scientists gave me a unique opportunity to be the shoulders students like me could stand on as they pursued their STEM careers. My former students, many of whom are students of color, are pharmacists, doctors, lawyers, chemists, entrepreneurs and STEM educators. I find pride in my 22-year career as a STEM educator and advocate. I am also proud that I have indirectly had a hand in increasing the numbers of minorities in STEM. My heart overflows with joy knowing I helped them to bloom as scientists.

STEM Success Within a “Chilly” Educational Environment

I remember it like it was yesterday when my sixth-grade teacher called me to the front of the classroom for one of her culturally accepted and stern, public assessments of student progress. As I walked towards her, she began to report, “You got more than thirty-six wrong on the math homework. For every wrong answer, I am going to beat you.” She pulled out her leather belt, and hit me in the palm of my hand thirty-six times. I returned to my seat crying and embarrassed. She added, “You will never learn; you are worthless; you will never make it to high school.” To hear those words from a person who is revered as a role model can damage a child’s self-esteem. To offer motivation in the form of punishment and embarrassment should be illegal. However, that wasn’t the case at Plainville Primary (pseudonym) and to the contrary, in that moment during my long walk of shame back to my seat, I pledged that nothing would hold me back from achieving my goals. As a matter of fact, this marked the beginning of an audacious quest in which I decided I would graduate high school and pursue a college degree.

I completed elementary school and attended a vocational, junior high school for three years. During the last year of junior high, my mom informed me she could not pay for me to attend a tuition-based high school (versus free trade-based) or for me to take the Caribbean Exam Council (CXC) college entrance exams. At that point I realized that I needed to reunite with my father, who lived on the opposite side of the island in Jamaica, and was more than able to pay for a college preparatory high school and the CXC exams. With transportation paid by a church member, I left and went to live with my dad. He enrolled me in one of the most prestigious, catholic high schools on the island. Accounting was predetermined for me as a major study by my high school counselor, who perceived it as most useful and practical for a female student. I wanted so badly to be a science major, but I was too afraid to advocate for myself or sign up for the classes I needed. Therefore, my love for science was placed on the back burner.

In my last year of high school, I was accepted to nearby Universal Caribbean College (pseudonym) as an accounting major. Determined to attend college by any means, I packed my belongings and moved immediately in the dorms on cam-

pus. On the last day of new student orientation, students had to stand in a long line to pay for classes or make payment arrangements. Unfortunately, the student loan that I expected to receive was not awarded. I had no money. I had two options: I could pack up and return home or stay there and delay one semester of studies to work full-time on campus as a janitor and cafeteria worker. I chose the latter to earn money to pay for classes. I worked on average between 90 to 100 hours per week for an entire semester. I started my college career as an accounting major the very next semester. I was never happy with my decision to study accounting, but I finished an associate degree anyway. Discouraged by my friends and with no support from my family, I began to apply for schools in the United States. I was accepted to one university, but could not raise enough money to attend, so I took two years off and traveled to work with different programs. The same university eventually offered me a scholarship, and I eagerly relocated to the northern part of Texas to continue my studies at a private, religion-based institution. I was starting over, as a transfer-international student, far away from the stereotypes of what I was supposed to be. I had learned to advocate for myself. I added biology as my major.

During my first semester as a student and not a stranger to hard work, I enrolled in seven classes: Introduction to Chemistry, Anatomy and Physiology, Introduction to Probability/Statistics, Psychology, Medical Terminology, Human Growth & Development and Introduction to Sociology. However, good work ethic wasn't enough. I did not have sufficient foundation in science and that semester was extremely difficult to say the least. Most of the time it seemed as if I was holding on to dear life just to finish one week of assignments then to suffer on to the next. Everything was new except for the harsh educational climate I had similarly endured at home. I had several experiences and interactions with my all White, male professors that made me question, "Why am I doing this? Is it just to prove a point? Did I really love science as much I remembered or was it because I was told that I could not do it"? My chemistry professor suggested that it would be best for me to return to Jamaica. The anatomy professor shared his belief that God had something different in mind for me, and declared it was not anatomy or physiology. The statistics professor informed me, during midterms, that having a C on my transcript will hurt me in the future; it was only midterm and there were two more exams and the final that I would have to take. After much persuasion, I dropped the statistics course. I ended with marginal grades in the others. After just one semester, my future looked dim and hopeless. Scholarship funding ran out; I didn't really understand the total cost of attendance nor did I realize that the scholarship offered would not be enough to cover two years of expenses. I was unable to pay for the second semester, yet hope came from an unlikely source. At the university, there was one Black, female professor in the nursing department. Ironically, I had met her briefly during my travels to Mexico. Unbeknownst to each other, she had applied to teach there around the same time I had received my scholarship offer. This professor became my refuge when she invited me to

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live with her for the remainder of my time there. She provided food, shelter, encouragement, and the mentorship that I needed. To pay for tuition and books, I earned other scholarships, worked on campus, and cleaned houses off campus. After 2 ½ years of intense studying, I earned a Bachelor of Science degree with a concentration in Biology and Business. I contribute a major part of my success to that one Black, female professor; she became my family away from home. Her support neutralized the chilly climate of the university as a whole. She modeled for me what mentoring and advocating for students is all about.

After undergraduate school, I decided to move to New York City where I worked as an educational coordinator. While there, I planned to pursue graduate studies in epidemiology, but was unable to find a program that was flexible toward full-time working students. I opted to pursue a Master of Science in Education; I figured, at least, it would help me to do my current job even better. I completed my master's degree, but was still haunted by the desire to work in a "pure" science field. I finally returned to Texas to pursue a second graduate degree in biology at a public, regional institution. During the course of my latest studies, my life was met with one major challenge after another. At the very start, there was a delay in processing my paperwork as an international student, which jeopardized my ability to receive in-state tuition and to work on campus. I had just enough money to enroll in first semester classes. I spent an entire semester with little money for rent or food; I made a deal with an apartment complex for living arrangements. A friend donated money for food. In order to secure a position as a graduate lab assistant, I worked there the first semester without pay as Homeland Security reinstated my status as an international student.

I wanted to give up and go home. Again, I asked myself, "What am I doing here"? I was at a point of utmost despair when I met a fellow Jamaican student who had recently finished her graduate studies in biochemistry. She became my 'big sister,' my mentor and my adviser. She reinforced my determined spirit to keep fighting. Then as sudden as she came into my life, she left—she passed away with breast cancer. Now deciding to give up, I didn't enroll next semester. When I eventually returned to school, I took a course with one of my first female professors. Her influence and positive impact gave me strength to continue my course of study. It was during the last year of my studies I encountered *another* chance meeting with a current doctoral student in a neighboring city; she told me about a new Black female professor on campus that had impacted her life. Accepting these 'chance' meeting as Divine intervention, I sought this professor out and realized we shared a similar background in STEM. I volunteered as much as I could with her work even though she was in a different program at the university; she mentored me in STEM education research and service learning. In December 2016, I graduated with a Master of Science in Biology. My research focus, and thesis, was *Students' Attitudes toward Science: How Gender Differences Influence Students' Attitudes in Secondary Classrooms with Resident Scientists*.

In my journey, however difficult and scarce of mentors within my field of study, I was persistent and charged feverishly forward in my STEM path—a path that was not straight by any means. I endured and managed to grow beyond the difficult moments, inspired by my desire to be in a position to give back and have a great impact on others. For every female of color whose white, male professors tell her, explicitly or implicitly, that science is not for her, I will be there as an example to show and guide her otherwise. Currently, I am a biology instructor at a community college in western part of Texas, and have started to focus my attention to create a STEM Summer Camp for school-aged girls in Jamaica. Energized by my current path, I will stay engaged in STEM by combining academic excellence and research in science education. My quest is to ultimately earn a Ph.D., contributing to research in science education and paying forward the opportunities that were given to me.

Despite Stereotype Threat: Once an Engineer Always an Engineer

As a young girl, I wanted to be an astronaut. I also wanted to be a scientist and do experiments in a lab. Those dreams came from watching TV. Back then my family's financial situation was challenging to say the least, thus television became my window to the world. One of my favorite activities was watching the space shuttle launches with my grandmother. She was the one who planted the seed for higher education before I even started school, partly because it had been her own unrealized dream. Furthermore, she was the most supportive person throughout my educational career. She was passionate about learning and passed this on to me.

While in elementary school, I signed up for as many extracurricular activities as I could. But even so, I wanted more out of school. Science was almost absent from the curriculum. To satisfy my longing I would experiment at home with anything I could get my hands on. In fact, most of my enduring memories from my childhood involved me hanging around my grandmother's sewing shop playing with her materials and tools. I received my first sewing machine when I was in elementary school. My first design was a clown dress for my doll; I drew it, cut it, sewed it and donned it on my doll. This was huge! It was also my first *real* mathematics lesson. Suddenly I had a conceptual understanding of measurement.

For middle school, I wanted to attend a math and science magnet school. However, the school did not provide transportation and my family's daily schedule was already complicated enough with 4 children attending 4 different schools. Without access to a quality STEM based curriculum, my interests and attitudes toward school changed. By the time, I reached the 10th grade I had lost my motivation to participate in extracurricular activities and no longer aspired to become an astronaut or scientist. Despite this, I still excelled in math and science; it came so natural to me. Then, for my junior year I enrolled in a new school. The new

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school's principal placed me in advanced mathematics because I had made A's in geometry. I did not know what this meant until I showed up to class the next day—it was pre-calculus. My classmates seemed to know the material very well while I had no clue of what was going on; I was lost. To make matters worse, I felt like a complete outsider. As a result, and for the first time in my life, I received a failing grade on a test. However, the teacher's encouragement incentivized me to work harder and consequently my grades began improving. What appeared to be a curse turned out to be the key to my future; I was forced to finally learn how to study to succeed in those advanced classes that challenged me. I gained transferable skills and discipline that proved to be the foundation for my journey ahead.

Then time came to apply for college. I was not sure about what to pursue or where to start. I felt inclined towards engineering, but I still questioned my abilities as a result of my academic struggles at this new school. In addition, being a first-generation college student, I had to learn to navigate the entire collegiate system by myself. For instance, due to a few mistakes I made during my application process to a larger institution, I missed the first round of admissions evaluations. So, I opted for a smaller, 2-year vocational school that was within walking distance from home. I chose to pursue natural science because it was the only articulated transfer program offered whereby credits could be used toward a bachelor degree. In the beginning, I thrived and enjoyed all my classes. That was until I had to dissect an animal. I just could not bring myself to do it. When I expressed this to my biology professor, who had offered me an internship, he told me that I would get used to it. I knew I would not and that it would be imperative to reconsider my options. My accomplishments in the natural science program, however, made me feel optimistic about engineering school. With the help and encouragement of a counselor, I transferred as soon as I was done with the basic requirements. I was accepted to begin the following fall at the College of Engineering at the most prestigious universities in Puerto Rico. I was proud. I felt empowered.

The time I spent in engineering school was filled with constant challenges. It took me five years instead of the expected three to finish my undergraduate degree as a transfer student even though I transferred with an equivalent to two years of course credits. First, it was difficult to fit in not only because I was pursuing a major dominated by males but also because of my socioeconomic status. People in my demographic group—low SES, females—would often drop out. On top of that, I did not have all the background knowledge I needed. The K-12 schools I attended did not have STEM programs and my focus at the two-year school was natural science. In contrast, most of my peers had attended very prestigious or specialized K-12 schools and started out at the 4-year university. To my advantage, by then I had learned to look for help. I began seeing a counselor on a regular basis and eventually developed a support network with other students with similar backgrounds. Since these students were first-generation college students as well, we shared some of the same difficulties and helped each other figuring out solutions.

I finished college with an undergraduate degree in mechanical engineering with plans to work in engineering design. Unfortunately, the opportunities in this career field were limited. In addition, my family members insisted that, for a woman, it was better to work for the local government. That's what I did. Yet, I found myself surrounded by unmotivated people waiting for retirement. I despised my job. With hopes of finding opportunities to grow, I ventured into construction. As warned at the time, women in this career field were not taken seriously. To gain respect I had to assume a hostile attitude to assimilate into that environment. A year later, unhappy and dissatisfied, I was back on the job hunt. I finally landed an interview at an engineering design firm. However, I was not hired. The manager explained that since he would have to train me like an entry-level employee, he could not match my present salary. He went on to state that even if I accepted the much lower salary, he would still be reluctant to hire me because he did not think I could manage long with an anticipated income lower than living wage. Frustrated, I turned to the pharmaceutical industry. There, I was basically exploited as a secretary, tasked with processing massive amounts of documents every day for long hours. None of this related to any of the reasons I went to engineering school. On occasion, I would find ways to utilize my technical skills by extracting and offering data using software. If I was lucky, I would analyze and generate reports using self-determined algorithms. I questioned if I would ever land my dream job to become an engineer.

After six years of going in circles, I needed a break. I relocated to the continental US and became a substitute teacher while I thought things through. During this time, I worked mostly with children from low socioeconomic backgrounds. Soon I realized that there was a lot in common between these children and me. Little had changed since I was a young girl. The chances for students from low socioeconomic backgrounds with inclinations towards STEM to develop their abilities are limited and these chances decrease even more when students are English language learners (ELLs). Aware of the possible setbacks they would encounter and the importance of having opportunities to develop their skills, I thought I could make a difference if I served as a teacher for at least a few years. I earned my certification to teach. While working at the elementary school level I met countless students with a tremendous disposition for STEM. In fact, one year I had a whole class of students that would rather miss recess than miss science. Being able to expand their world of possibilities made me feel accomplished. Becoming an advocate and improving my teaching skills for their sakes were of utmost importance. To that end, after six years teaching, I went back to school to pursue a Master of Arts degree in bilingual/bicultural education. And while that journey was not an easy one for me, I graduated in December of 2016. In the upcoming years, I plan to continue advancing my career by pursuing a doctorate degree. I do not question myself anymore about whether or not I will ever find my dream job. I am an engineer by training and I am also a STEM educator. As long

as I am able to inspire and help students realize their true potential I will be on the right path.

Understanding the Cultivation of Stereotype Threat and Imposter Syndrome

As a common theme emerged from the stories of these four women, the worry of finding one's fit and place in this world is often magnified by internalized race-based and gender-based stereotype threat as well as self-doubt in one's own ability. As a human factor in the pursuit of scholarship, eliminating stereotype threat and imposter syndrome is an impossible task. What we can do is reduce the consequences related to such phenomenon (Garden, 2009). To do that we must first understand how the phenomenon presents itself and is cultivated.

The journey of these four women of color, and the many commonplace stories of others like them that they have witnessed substantiate a critical truth: marginalized and underrepresented students' development through the STEM pipeline is centered on race and gender, and is positively or negatively impacted by [un]intentional and [in]formal actions of others. Their stories provide an additional framework by which to inclusively address race and gender diversity within that STEM pipeline. The lived experiences of these four women of color revealed "leaks" throughout the STEM pipeline from the home to school to the workforce. Collectively cogitated, what crystalizes is a reconciliation of five major presumptions: (1) without a sense of agency, cultural discontinuity is at the forefront of an almost pre-destined journey for women of color in STEM, (2) STEM talent will initially surface and is influenced by the values and circumstances within the home and community, (3) a disconnect between the manifestation of these talents and the appreciation for them within formal educational settings play a role in the early inception of imposter syndrome in women of color, (4) sometimes, that development is further fermented by a culture-blind curriculum and/or inadequately trained or unresponsive educators, and (5) With proper mentoring, STEM success can be achieved even in the chilliest of educational and male-dominated work environments.

Reducing the Consequences of Stereotype Threat and Imposter Syndrome

Even more promising, the collective stories of these four women of color reveal that if STEM is a major part of their identity, it will remain as much a part of them as their primary, race and gender identity no matter the path in which their journey may take them. It is in the culturally responsive and progressive development of their STEM identities that the consequences of stereotype threat and imposter syndrome can be reduced.

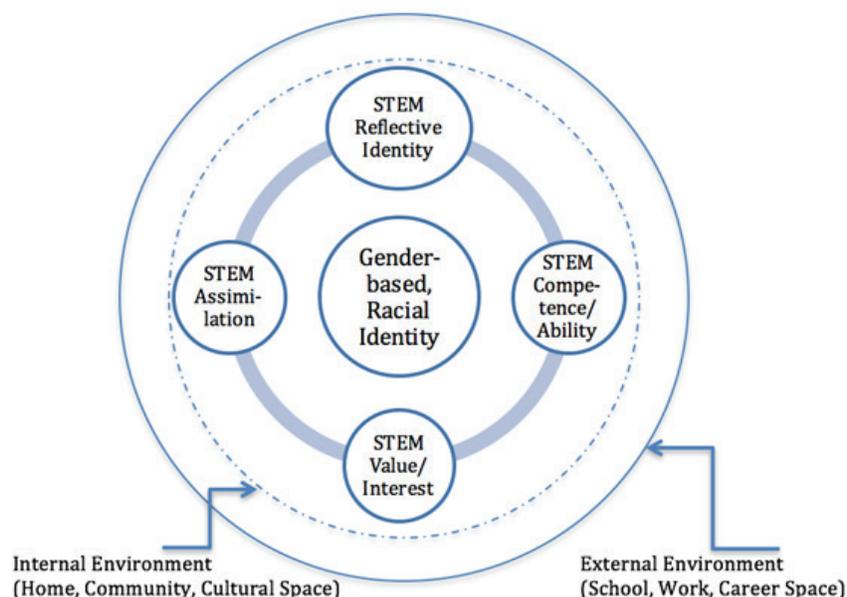


STEM Identity Development

Collins (2018) contended that “given that a student’s cultural milieu and interactions with the academic STEM environment may differ based on an individual’s race or ethnicity, it is important to examine student STEM identity and talent development through a lens that incorporates race and ethnicity” (p.146). She further noted that “the development of the students’ STEM identity is the result of reciprocal interactions among various psychological factors, individual behaviors, and the outside environment” (p.146). Confirmed by Vygotsky’s social development theory of cognitive development, we know that individuals will mimic and internalize the demonstrated ideas, values, strategies, and actions of those closest to them, which includes family members, teachers, peers, and event-technology (TV, computers, etc.). As such, these influencers are considered MKO’s (More Knowledgeable Others), whereby a learner perceives better understanding or higher ability level (Vygotsky, 1987) in STEM through them. Confronting color-blind approaches to talent development, Collins posited that Black students’ persistence throughout the STEM pipeline and across the lifespan is character-

Figure 1
Contextual Model for Black Student STEM Identity

Note. STEM = science, technology, engineering, and mathematics.
Source: Collins (2018). Reprinted with permission.



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ized by “a cyclic attitude toward one’s STEM self-concept, sense of belonging in STEM fields of study or discipline, and the perception of one’s own STEM cognitive ability” (p.160). Supported by CLIC (Content Learning and Identity Construction) theoretical framework (Varelas et al., 2013), Figure 1 illustrates the contextual model for Black Student STEM Identity (BSSI; Collins, 2018).

According to the model, there are four basic questions that Black students internalize. The affirmative answers to these questions are interconnected in ways that foster a STEM identity that reduces the consequences of stereotype threat and imposter syndrome. The first of these, “Do I belong in a STEM field?”, is affirmed by reflective identity. The other three questions are related to perceived possibility for success. Black students will constantly question their ability to learn STEM content in the context of its utility (value/ interest) within their environment. And due to the socialized nature of race and gender, they will also evaluate their engagement (assimilation) in relation to the cultural practices of the STEM field (i.e., disciplinary processes, language, discourse, and norms). As students become more central members of a disciplinary community and engage in its cultural practices, changes in identity and knowledge as positionality occur (Varelas et al., 2013) and the cycle continues.

More so for Black females, who are not typically socialized and raised to be scientists and engineers, it is important to nuance the opportunities and experiences for a positive STEM self-concept (Collins et al., 2019). A more comprehensive approach is necessary to address the cognitive and social factors that influence STEM retention and persistence (Rodriguez et al., 2018). Proactive steps to bridge gaps between college and the STEM workforce are critical, including the psychosocial support needed for Black females prior to even enrolling into college (Ford et al., 2018). One effective way to do that is through mentoring.

STEM Mentoring

The contexts and benefits of mentoring are well documented within the literature (Kochan and Pascarelli, 2003; McKensey, 2016). Culturally responsive STEM mentoring programs are designed to fortify and reinforce the STEM pipeline for all students, especially for underrepresented students. At the post-secondary level, universities are in a unique position to offer mentoring across the life span in collaboration with secondary education and community partnerships. One such program, Mentoring Matters (Collins, 2017a), serves as an example for effectively addressing stereotype threat, imposter syndrome, and “chilly environment.”

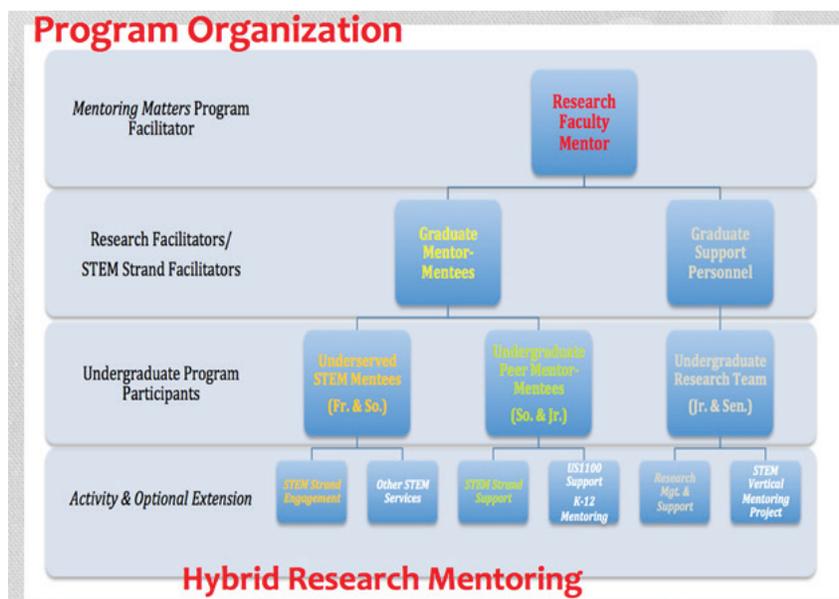
These four women of color collaborated to facilitate a pilot study,¹ to uncover effective strategies to positively affect STEM retention & persistence in CLD (culturally and linguistically different) students. This pilot study (n = 27) was conducted as part of a service-learning project within a graduate-level mentoring course. Informed by CLIC theoretical framework and Collins’ (2018) BSSI

model, and utilizing a vertical mentoring approach, the professor of the course and a community partner (research mentors) mentored and coached three doctoral students and two recent master-level graduates, as project facilitators (project mentor-mentees), in the design of three research-based STEM projects: STEM Research, STEM G.I.R.L.S. (Girls integrating research and learning in service), and STEM Leadership.

Under the guidance of these project facilitators, ten master-level graduate students (graduate mentors) who were enrolled in the mentoring course were divided into three mentoring teams to implement the activities for the STEM projects. Select undergraduate students (mentees) who self-identified as underrepresented (Black, Hispanic/ Latino, and female) students in STEM signed up as participants for one of the three STEM projects.

While the components of vertical mentoring practices are not novel, put together, the program's organization forms an innovative hybrid model (Keller & Pryce, 2010; Welch et al., 2012) for collaboration that offers culturally responsive benefits associated with content-based learning communities (Kurepa, 2012), a nested mentoring structure (Fouche & Lunt, 2016), and co-mentoring principles (Clarke, 2004). Eliminating the shortcomings of a 'one size fits all approach' to mentoring (Gratton and Truss, 2003) even within a single program, the use

Figure 2
Program Organization and Vertical Mentoring Approach for Mentoring Matters Program



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of a vertical approach that was dynamic (Fang & Van Vliet, 2006), educationally multi-leveled (Livesay & Rogge, 2006), and interdisciplinary (Olivero, 2014) proved to be very effective. It employed all three elements of Vygotsky's theory—social interaction, MKO, zone of proximal development (Murphy et al., 2015) in the cognitive and social development of STEM students. It offered a sustainable way (Nagchaudhuri et al., 2004) to also retain junior faculty in higher education (Clarke, 2004) as students continued to advance to new levels within the mentoring process throughout their collegiate career.

Preliminary findings (Collins, 2017b) from post-program surveys, online discussions, and mentor journals for the Mentoring Matters study revealed that stereotype threat and imposter syndrome were not a concern for any of the participants, including the four women of color featured in this article, while they were engaged in the project over the course of the semester. The project mentors and graduate mentors found that their confidence and skill set for culturally responsive mentoring increased over the course of the semester. Additional analysis and research are warranted to tease out specific activities that reduced the consequences of stereotype threat and imposter syndrome.

Implications for All STEM Stakeholders

Whether as supervisors, mentors or advocates, it is the ethical responsibility of researchers, professors, practitioners, and educators to model effective and appropriate development of the STEM interests and talents that will positively cultivate and nurture STEM identity, especially for our underrepresented and underserved students in STEM. These four women of color were all drawn to shield other marginalized students from the issues they faced in the STEM environment. Each of them has become a STEM educator and/or researcher committed to training the next generation of STEM practitioners. They have dedicated much of their adult life advocating for equity and access in STEM for students that come from similar backgrounds. They offer a voice to address cultural discontinuity, value depreciation of STEM talent, culture-blind curriculum, unresponsive educators, and male-dominated environments. Their responsive practices inform new perspectives in providing appropriate support and finding ways to reduce/eliminate the effects of stereotype threat and imposter syndrome at all levels of the STEM pipeline.

Note

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References

- Ceci, S.J. & Williams, W.M. (2011). Understanding current causes of women's underrepresentation in science. *Proceedings of The National Academy of Sciences of The United States of America*, 108(8), 3157-3162.
- Clance, P.R., & Imes, S.A. (1978). The imposter phenomenon in high achieving women: Dynamics and therapeutic intervention. *Psychotherapy: Theory, Research & Practice*, 15, 241-247.
- Collins, K.H. (2017a). *Mentoring matters: Changing the F.A.C.E. of STEM one mentee at a time*. <https://mentoringmatters.wp.txstate.edu>
- Collins, K.H. (2017b). *Metrics for supporting the social, emotional, and cultural context of talent development in underrepresented STEM students. A service-learning impact report for CI 5383: Mentoring across the life span*. San Marcos, TX: Office of Service Learning Excellence, Texas State University.,
- Collins, K.H. (2018). Confronting colorblind STEM talent development: Toward a contextual model for Black student STEM identity. *Journal of Advanced Academics*, 29(2), 143-168. <https://doi.org/10.1177/1932202X18757958>
- Collins, K.H., Joseph, N., & Ford, D.Y. (2019). Missing in action: Gifted, Black girls in science, technology, engineering, and mathematics (STEM). *Gifted Child Today*, 43(1), 55-63. <https://doi.org/10.1177/1076217519880593>
- Clarke, M. (2004). Reconceptualising mentoring: Reflections by an early career researcher. *Issues in Educational Research*, 14(2), 121-143.
- Fang, Z., & Van Vliet, E.M. (2006). Work in progress: A unique self-supporting program for woman engineering students at a Christian university. *Proceedings of Frontiers in Education*. 36th Annual Conference for Frontiers in Education. doi:10.1109/FIE.2006.322675
- Ford, D.Y., Grantham, T.C., & Collins, K.H. (2018). Giftedness, racial identity, and social-emotional learning: Challenges and recommendations for culturally responsive practice. In F. Hellen & R. Piske (Eds.), *Emoção E Criatividade Na Educação De Superdotados E Talentosos [Emotion and creativity in gifted education]* (pp. 89-106). Jurua Editor.
- Fouche, C., & Lunt, N. (2010). Nested mentoring relationships reflections on a practice project for mentoring research capacity amongst social work practitioners. *Journal of Social Work*, 10(4), 391-406.
- Garden, J. (2009). *The imposter syndrome: How to replace self-doubt with self-confidence and train your brain for success*. Chesapeake, VA: Big Dream Media
- Gratton, L., & Truss, C. (2003). The three-dimensional people strategy: Putting human resources policies into action. *The Academy of Management Executive (1993-2005)*, 17(3), 74-86.
- Hoppe, T.A., Litovitz, A., Willis, K.A., Meseroll, R.A., Perkins, M.J., Hutchins, B.I., Davis, A.F., Lauer, M.S., Valantine, H.A., Anderson, J.M., & Santangelo, G.M. (2019). Topic choice contributes to the lower rate of NIH awards to African-American/ Black scientists. *Science Advances*, 5(10), eaaw7238. <https://doi-org//10.1126/sciadv.aaw7238>
- Keller, T.E., & Pryce, J.M. (2010). Mutual but unequal: Mentoring as a hybrid of familiar relationship roles. *New Directions for Youth Development*, 2010(126), 33-50. doi:10.1002/yd.348

180 Consequences of Stereotype Threat and Imposter Syndrome

- Kochan, F.K., & Pascarelli, J.T. (2003). *Global perspectives on mentoring: Transforming contexts, communities, and cultures*. Charlotte, NC: Information Age Publishing.
- Kurepa, A. (2012). Vertical peer mentoring and advising: A structure for student involvement in multi-level advising. *Mentor: An Academic Advising Journal*, 4.
- Livesay, G., & Rogge, R. (2006). *Vertical mentoring: Closing the loop in design*. Paper presented at the ASEE Annual Conference and Exposition, Conference Proceedings, www.scopus.com
- McKinsey, E. (2016). Faculty mentoring undergraduates: The nature, development, and benefits of mentoring relationships. *Teaching & Learning Inquiry*, 4(1), 1-15.
- Murphy, C., Scantlebury, K., & Milne, C. (2015). Using Vygotsky's zone of proximal development to propose and test an explanatory model for conceptualising coteaching in pre-service science teacher education. *Asia-Pacific Journal of Teacher Education*, 43(4), 281-295. doi:10.1080/1359866X.2015.1060291
- Nagchaudhuri, A., Williams, M., Singh, G., Mitra, M., Conry, R., & Bland, G. (2004). Vertical integration of students and mentoring activities pave the way for Phase-II of UMES-NASA experiential learning project. *ASEE Annual Conference Proceedings*, ASEE 2004 Annual Conference and Exposition, "Engineering Education Research's New Heights", 15267-15276.
- National Science Board & National Science Foundation. (2020). *Science and engineering indicators 2020: The state of U.S. science and engineering*. NSB-2020-1. <https://nces.nsf.gov/pubs/nsb20201/>
- Olivero, O.A. (2014). *Interdisciplinary mentoring in science: Strategies for success*. [electronic resource] Elsevier/AP.
- Rodriguez Amaya, L., Betancourt, T., Collins, K.H., Hinojosa, O., & Corona, C. (2018). Undergraduate research experiences—mentoring, awareness, and perceptions: A case study at a Hispanic serving institution. *International Journal for STEM Education* 5(9). doi: 10.1186/s40594-018-0105-8
- Sandler, B.R. 2009. *The chilly climate: Subtle ways in which women are often treated differently at work and in classrooms*. <http://www.bernicessandler.com/id23.htm>
- Steele, C., & Arsonan, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, 69(5), 797-811.
- Varelas, M., Martin, D.B., & Kane, J.M. (2013). Content learning and identity construction: A framework to strengthen African American students' mathematics and science learning in urban elementary schools. *Human Development*, 55(5-6), 319-339. <https://doi-org/10.1159/000345324>
- Vygotsky, L.S. (1987). The development of scientific concepts in childhood. In R. W. Reiber & A. S. Carton (Eds.), *Collected works of L. S. Vygotsky: Vol. 1* (pp. 167-242). New York, NY: Plenum.
- Welch, J. L., Jimenez, H. L., Walthall, J., & Allen, S. E. (2012). The women in emergency medicine mentoring program: an innovative approach to mentoring. *Journal of Graduate Medical Education*, 4(3), 362-366. doi:10.4300/JGME-D-11-00267.1