INTRODUCTION

Playing to Our Strong Suits

"When baseball is the only game in town, football players are always playing today a weak suit. Until eventually, they stop playing the game."

—MARY MONTEL BACON

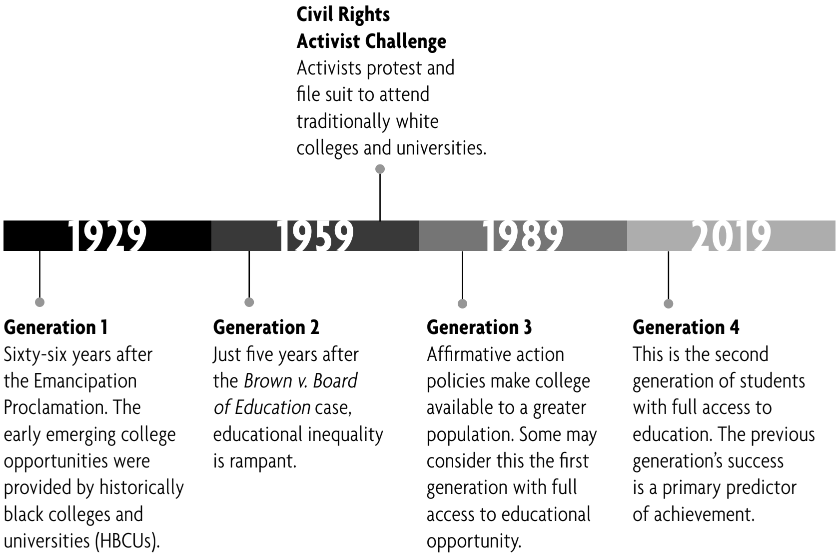
I DRIFTED THROUGH HOURS of mundane professional development while attending my first International Baccalaureate Conference. But when I heard Dr. Mary Montel Bacon speak these words, I sat up and paid attention. I was enthralled by her energy, but confused by her message. The analogy was striking, yet so out of place. What could she mean? In the next hour, Dr. Bacon would outline a detailed, thoughtful historical narrative about why it was almost illogical to ask some children to participate in an educational system they deemed irrelevant. The point resonated deeply with me. I considered the complexity of her analogy. The point she was unpacking was that if we provide students with only one way to find success, it makes sense for them to seek success on their own terms. In the US educational system, we were selling a vision of educational success that did not make sense for many kids. Teachers were teaching science, but they forgot that we are not teaching *science*; instead, we are teaching *people*. We want the people to learn science, but ultimately, we cannot act as if the people do not matter. Dr. Bacon's bold assertion suggested that if we ignore the needs of our students, they will ignore schooling as an institution.

Baseball, in Bacon's observation, represents an education that makes no accommodation for the students in the room. In a "baseball" classroom, teachers focus merely on the content. The suggestion was that it is reasonable to expect students to opt out of a system because it does not fit who they are. This system hints: "You are not valued." "What you care for is not important." "The things that motivate you have no connection to school." I was dazzled by her message—and by how it generated a shift in the crowd. What came next forever changed my vision of education.

THE GENERATIONAL EDUCATIONAL DILEMMA

What I learned that day was Mary Montel Bacon's theory of the *generational educational dilemma*; what I gained was a theoretical lens that would last a lifetime. This theory offered an enlightening lens on race and education that begged scholars to view education along a timeline. The generational educational dilemma claims that years of historical oppression have produced our current educational conditions, where inequitable education is the norm. Even after twenty-one years in education, I have yet to encounter this idea in text form. Dr. Bacon's argument is that full access to a high-quality education is something new for most African American and Latinx children—only a generation old. Take a look at the timeline in figure I.1. A college student who is prepared to graduate from college this year would be approximately twenty-two years old. That means they were likely born in 1996. But when were their parents' born? Let's assume the average person has a child by age twenty-eight. Their parents were born in 1968. That means our students' grandparents were born in 1940. And in 1940, the timeline indicates, educational opportunities for African

FIGURE I.1 Generational educational dilemma timeline



American and Latinx were little to none. African American people in the South were not allowed to go to white colleges and had limited access to high school. Aside from a small handful who attended predominately white institutions in the South, African Americans had only one option for college education, a historically black college. And pre-*Brown v. Board of Education*, such a school would likely not be able to obtain equitable physical resources and local funding.[1]

When we move to the years when our college student's parents were born, around 1966, we find the country entrenched in an epic battle for educational and civil rights. Students across the country were fighting to integrate elite educational institutions. That is, equitable educational access was clearly not yet available for African American and Latinx students.

The first assumption of the generational educational dilemma suggests that full access to a modern educational opportunity did not happen for most black and brown families until the 1970s or ’80s, and that we are in the first generation of full educational rights for students of color. Now, terms like *First Gen student* are used to remind us that it is more challenging for students who do not come from affluent families with histories of college-going to make their way to a college institution. Educational structures bear the weight of their historical legacy. They reflect the privilege of some and discriminatory practices used against our forefathers, and they should never be examined in a void.

As I think about science teaching and learning in contemporary schools and communities, I think about them in this context. This book was written to help craft the narrative and paint the picture of how the psychological, sociological, and linguistic histories of oppression have made their way into contemporary science classrooms. It is intended to show the realities of years of educational disservice to communities, but it is also designed to share tried and true practices that can improve the way urban children experience science.

A CONTEMPORARY DILEMMA IN SCIENCE EDUCATION

Along with the generational educational dilemma that afflicts the US education system overall, there is a generational educational dilemma in science education as well. Unlike the dilemma framed in Bacon’s analysis of the broader educational system, contemporary science education suffers from a history of stereotyping, linguistic prejudice, and cultural conflict that undermine a school’s capacity to provide effective science education for all.[2] The science that is taught today reflects generations of science that was taught with a single audience in mind. This lineage now shapes the way students experience contemporary science classrooms. *Science in the City* explores the impact of this heritage.

STEREOTYPES AS DRIVING FORCES IN STEM

One of the most obvious and well-researched aspects of science's generational dilemma involves how stereotypes determine who can participate in science. Even at the time of writing, the nation's number-one comedy television program, *The Big Bang Theory*, portrays old, tired images of the science community, where the stereotype of the successful scientist is an awkward white male who lacks basic social skills.[3] The show sends a resounding message about who belongs in science.

The stereotypes about who can become a scientist do not merely exist in television, but have been reinforced for generations in the general social milieu. These stereotypes indirectly reference a perception of who should *not* be a scientist. If white, awkward men are scientists, then are cool Latinx women immediately out of the consideration? Stereotypes work this way—they frame an expectation and establish a seed of doubt for those who dare to defy them. I am not suggesting that a generationally persistent stereotype determines who can become a scientist. Instead, I am suggesting that existence of that stereotype presents invisible obstacles for those who do not fit this image. A talented African American male student who dresses like the fourth member of the hip-hop group Migos will have to question whether or not science is a real option because of this real stereotype. A young woman who lives her life as a proud feminist will have to question whether or not physics is a place for her because generations of stereotypes send her a message that she does not belong. As students of color achieve in science fields at rates we have never seen before, they are achieving under the cloud of negative stereotypes about who can become a scientist. We cannot ignore the reality of the barriers these expectations impose.

Psychologists have explored the power of these subtle interactions, which they call *social identity contingencies.*[4] Valerie Purdie-Vaughns describes this perspective by explaining how cues of social interactions produce social identity contingencies: "Certain features or cues in a setting may create the expectation that a person's treatment will be contingent on one of their social identities. Social identity contingencies are possible judgments, stereotypes, opportunities, restrictions, and treatments that are tied to one's social identity in a given setting (Steele, Spencer, & Aronson, 2002) [p. 615]."[5] A social identity contingency is the cost that people must pay for existing outside of the box.

The "judgments, stereotypes, opportunities, restrictions, and treatments" are the ways that racial stereotypes shape a students' experience in classrooms. In the case of science, our generational expectations for who can participate in STEM create an environment where students constantly have to ask the question, "Do I belong?" For example, an African American student with long dreadlocks and gold teeth in an AP chemistry class might feel the need to show people just how smart he is because he understands that the expectations of who he is do not match the model of a "good chemistry student." This is wrong, but this is a social identity contingency. The issue has additional dimensions because there are other people in the room. If the teacher and other students have never encountered a brilliant person of color who loves to wear his hair in the traditional African dreadlock, they may assume that the student is not intelligent—another stereotype. This is an additional burden the student must manage. The awkward looks or surprised faces classmates may show when they hear this young man offer a detailed and accurate answer would constitute social contingencies. And these social contingencies have a powerful impact for how people experience science classrooms.

Science in the City examines the nuances of these interactions. When students speak eloquently about scientific information in language that reflects the culture that they are from, do teachers hear their brilliance? In this text we will integrate theories of sociolinguistics, cognition, and learning to examine how generations of cultural stereotyping have allowed teachers to teach students from a position of implicit cultural bias that crosses the borders of language, culture, and cognition. We currently exist in a dynamic multicultural and multilingual society. Thus, science teachers must develop a detailed understanding of the power of culture and language in their teaching and learning interactions.

This text spends the bulk of its time examining how the language of science stands as a central gatekeeper in the interactions that produce these contingencies. As Bacon explains, we often ask students to operate in cultural environments that are simply distant from their own culture. Language often stands as this barrier. Multilingual students who flow brilliantly back and forth between Spanish, English, Khmer, and various cultural dialects are simply not afforded the ability use the intellectual resources that define their home environments.[6] This is a calamitous mistake that does two things simultaneously. First is sends a resounding message that the culture of *these* young people is not valued in science. Second, it tells the students that language and culture they are from offer no scientific value, depth, or intellectual benefit. This is simply not true and reflects our inability to understand the powerful resources of the culture that students bring with them into their science learning environments. Scholars have examined this intersection for years; however, science educators have been slow to identify how to use these linguistic and cultural resources for science teaching.[7] A vision for an empowering STEM education must recognize the value of rethinking how language, culture, and cognition shape contemporary teaching and learning. *Science in the City* explores this vital relationship.

PURPOSE AND STRUCTURE OF THIS BOOK

Science in the City was written with three primary goals in mind. First, it describes how the subtle aspects of language, race, and culture have a specific impact on students of color. It examines how the unique nature of science teaching and learning exacerbates the conflicts experienced when race, language, and science cultures collide. Second, it uses research to offer new evidence of the emotive and cognitive impact of race, culture and science language. Third, this book aims to help readers translate theory and research into meaningful pedagogical practices that are founded on research.

The book is structured in two parts. In the first part, I explore how language and culture are vital aspects of teaching and learning from a theoretical and pragmatic position. The second part examines how we can use specific, well-researched teaching practices that will help your students retain science content and see how science is a relevant feature of their own culture.

Chapter 1 starts with story of James Meredith. It examines the context of his integrating the University of Mississippi and examines the notion of the *black tax*, the idea that people of color are judged harshly and have to pay an additional "tax" to have an opportunity to succeed. The chapter explores how language and race are intricately connected to science learning, but how for many students of color there is a tax to their way of community.

Chapter 2 explores how linguistic norms are established in classrooms. Although teachers and administrators arrive to classrooms environments from diverse academic and cultural experiences, they often fail to establish a culture where students can use their voice. Many adopt a common linguistic norm that privilege students providing "right answers" and discourages the adoption of spaces for hybrid language practices. The chapter explores how teachers discriminate against students based on unstated norms about what gets said and how language is to be used in science classrooms.

Students' science cognition and its association with the language is the subject of chapter 3. It describes how students can offer insightful science explanations that do not rely on science language and examines the consequences when teachers fail to understand to take into account students' cultural repertoires and ways of expressing their knowledge.

Chapter 4 is dedicated to connecting the issues of language, race, and identity to student learning. It explores theories of language and learning from both psychologists and cognitive scientists to examine how taking a cultural approach to understanding language would impact students' science learning. This chapter argues that providing students with language they can understand to begin a lesson is an essential link in their being able to successfully develop a clear conception of a phenomenon.

Chapter 5 explores a teaching approach known as *disaggregate instruction*, which focuses on addressing issues of cognition and affect in contemporary classrooms. Although it was specifically designed for teaching in science courses, disaggregate instruction concerns itself with language, first building initial cognitive understanding using students' own linguistic resources and then explicitly teaching students to use the new discourse of the lesson. When using this approach, teachers will introduce the big ideas through simple language and explicitly define the language valued in the classroom learning environment. The object is to reduce the anxiety and affective responses to complex discourse by reducing the cognitive load at the beginning.

Chapter 6 uses the story of a "hero teacher" to frame the idea of explanation as the foundation of understanding best practices for teaching and learning. It offers a number of instructional practices that help students experience the basic aspects of science ideas but focuses on developing mastery by discussing the science in culturally meaningful ways. This *generativity* approach to teaching specifically focuses on rethinking how we can use formative assessment as a tool for teaching.

In chapter 7, the story of the rise of Netflix is used to explain how excellent science teaching will require policy makers to focus on the strengths and weaknesses of contemporary STEM education.

This chapter explores how science educators must rethink our current instructional models. Unlike other disciplines, science has a dynamic set of external experts and resources. Chapter 7 explores the potential of these supplemental instructional resources. Finally, this chapter challenges educators and policy makers alike to rethink how we use technology to support science teaching. It proposes that technology can be used to enhance the cognitive and cultural experience for all students.

The simple message of *Science in the City* is that science teaching is the ultimate people business. We are not teaching a room of individuals who are the same from state to state and community to community. We have the privilege of teaching vibrant young minds who show up with a wealth of linguistic and cultural resources. To maximize their education, the next generation of STEM teachers must develop a deep understanding of how to use these resources to make science visible to these students. The point of teaching science is to provide young people with a lens that they can then use to change the world we live in. Science education is about speaking to everyone's strong suit and making sure science is among the things that feel like home.