Second-Class Citizens, First-Class Scientists: Using Sociocultural Perspectives to Highlight the Successes and Challenges of African American Scientists During the Jim Crow Era

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Introduction

> This is a strange time to be alive in America, in that regard. Close one eye, and we can seem to be moving toward a one-race society; close the other and we seem as racially conflicted and stratified as ever. Racism is still our madness. (Sullivan, 2012, para. 24)

The aforementioned quote may not be well received by many science teacher educators, yet it is difficult to argue that for a large number of students in our schools, it is still a challenge to move beyond the common myths and concomitant deleterious behaviors associated with the social construct of race. To move forward, we must understand our current status and our past. Within this context, educators can use anthropological skills to better understand science education in the United States. Indeed, these understandings can further develop in the science teacher educator the will to effect change through one's science teaching and scholarship.

The National Science Education Standards emphasize the need to focus on science, technology, and society (STS) as a part of science instruction (National Resource Council [NRC], 1996). For example, the NRC (1996) states that "middle school students are generally aware of science-technology-society from the media, but their awareness is fraught with misunderstandings. Teachers should begin developing student understanding with concrete and personal examples…" (pp. 167–168). In addition, the standards also highlight the need for high school students to understand the important role social issues play and have played in scientific and technological advances (NRC, 1996, p. 199). In the *Benchmarks for Science Literacy*, the American Association for the Advancement of Science (AAAS, 2009) devotes an entire chapter to "the scientific enterprise," where it is

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stressed that middle and high school students must come away from their science classrooms with knowledge and understanding about the many different kinds of people who have contributed to scientific and technological developments, some in spite of the restrictions placed on them within their particular society. Even in *A Framework for K-12 Science Education* (2012), it is acknowledged that science understanding is a cultural accomplishment and science instruction should include the contributions of people from diverse cultures and ethnicities. No matter where advances are made or who makes them, the world has the potential to benefit from them. Thus, science teacher educators have a strong and solid rationale for pursuing societal matters in science education.

Within societal matters rests the need to explicate the roles of African American scientists in the making of America, especially in the United States. Pragmatically, we need more Black scientists and students who are interested and prepared to succeed as science majors. Yet reports indicate that there continues to be a relative dearth of Black students who graduate with degrees in science (Czujko, Ivie, & Stith, 2008). However, it must be noted here that historically Black colleges and universities (HBCUs) are the places where most Black science majors are found (Czujko et al., 2008). These schools have some unique characteristics (e.g., identifying, nurturing, and recruiting future science majors, mentoring future scientists, and developing synergistic collaborations and partnerships with governmental agencies, private industries, and traditionally White colleges and universities) that contribute to their success in the production of scientists of color. These characteristics, which are beyond the scope of this chapter, merit further exploration by the reader.

A Story

Having recently earned a bachelor's degree in physics from a historically Black university, Lee was prepared to live the life of a physicist as he began work on his Ph.D. in physics at a historically White university. A year later, a confluence of events and experiences led Lee to reconsider his decision and think more about influencing the teachers who would educate the next generation of scientists. Thus he changed his graduate school aspirations to becoming a high school physics teacher. It was during this preparation that one of Lee's professors told him and his classmates that they needed to be aware and able to work with diverse groups of students. So, Lee walked into his first high school physics class with the awareness that the racially and ethnically diverse group of students in front of him deserved his best efforts to meet their needs. But what was deficit was his very limited set of knowledge and skills in how to teach this great group of students. Thus began a year of learning from his students in ways that could have at least been addressed in his teacher preparation program. Thank goodness for teachable and teaching students!

Questions to Consider

1. Is it possible for Lee to bring his prior experiences and background as a Black physicist to bear on his classroom's curriculum and instruction? If so, how should he go about doing it?
2. How could Lee's university professor have better prepared him for the realities of a diverse high school science classroom?

3. What might Lee learn from his students and their lived experiences that he can use to effectively teach them science?

The aforementioned story is an all too common experience for beginning secondary science teachers. Trying to address this dearth of knowledge about who does science has been the work of many noted scholars. Recently, science educators have attempted to use a psychological construct—sociocultural theory—to better explain what happens and what should happen in the science classroom. Sociocultural theory is typically associated with the work of the Russian psychologist, Lev Vygotsky. This theory posits that children's thoughts and behaviors are inextricably linked to the social context in which they find themselves (Vygotsky, 1979). In essence, what we know and come to know is intimately connected with our lived experiences, as well as the lives of others.

Recently, Verma (2009) focused on sociocultural perspectives as she examined curricular approaches linked to sociocultural perspectives for urban students. Verma's work builds on the research of numerous science education scholars (e.g., Lemke, 2001). This chapter will attempt to highlight the best of what we know about science teaching and learning, sociocultural theory (SCT), and Black scientists to create a knowledge base for secondary science teacher educators and candidates. For this chapter, I will attempt to address the following questions:

- Why Black scientists?
- Why the Jim Crow era?
- Who are some first-class Black scientists?
- What are some curricular connections and pedagogical strategies we can use to help secondary science teacher candidates prepare to teach multicultural science in their classrooms?

Why Black Scientists?

Let us clarify a few matters before proceeding further. First, the terms *African American* and *Black* will be used interchangeably throughout this chapter. Justifications can be found for using either or neither term (e.g., see Newport, 2007). While not trying to simplify a complex social issue, we just do not want to lose sight of the key issues to be addressed here. Secondly, we will focus on a short two-decade period in US history. However, the racial caste system known as Jim Crow was actually in effect in the United States from the 1870s to the mid-1960s. This legalized and institutionalized way of life, was widely accepted as the norm across the United States, being more acute in southern United States (Jim Crow Museum, 2012).

Thirdly, we will use several aspects of Critical Race Theory (CRT) to connect our exploration of Black scientists to the science education we hope to share with future science teachers. Critical Race Theory has beginnings in the legal profession in the 1970s (Delgado, 1995) and began to take root in education with the work of noted

scholars such as Gloria Ladson-Billings and William Tate, who began to articulate a connection between CRT and education (Ladson-Billings, 1998; Ladson-Billings & Tate, 1995). Four underpinnings are commonly associated with CRT:

- Racism is embedded in the fabric of the culture of the United States.
- Stories and narratives are essential to providing context.
- The concept of and actions based on liberalism merit constructive critique.
- Whites have benefited from civil rights legislation more than Blacks (Ladson-Billings, 1998, pp. 11–12).

Why the Jim Crow Era?

The first two aforementioned components of CRT (e.g., the permanence of racism and the effective use of stories and narratives) will serve as a backdrop for this chapter, as we will seek to use the period of Jim Crow to tell the story of African American scientists. Indeed, renowned historian Dr. Kenneth Manning (1999) made the case as follows:

> Although science purports to be objective and supposedly has imbedded in it a kind of democratic core, scientists are not science, they are not the thing itself—they are people who live in the world with other people and have many of the same social views and behaviors of society at large. Their institutions are hardly any different than institutions of other professions. The pursuit of science education conforms to the structure of that for any other kind of education. A segregated educational system has had the same effect, if not greater, on science in this country with regard to blacks as is has had on other provinces of learning. Even though the 1954 Brown vs. The Board of Education landmark decision was intended to eliminate segregation in education, we know that in many parts of the country segregation persisted. Not until the 1964 Civil Rights Bill was a minor milestone in the direction of eliminating segregation achieved. Then, opportunities for African Americans opened up at both the undergraduate and graduate levels at many white colleges and universities, and as a result, careers in the field of science became a firmer reality for many African American students. (Mickens, 1999, p. 3)

Based on the cogent points made by Manning, this chapter will take a closer look at Black scientists during the 20-year time period of 1945–1965. Strategies for using the challenges and successes of several scientists with secondary students will be shared, along with resources that can serve as primers for the science teacher educator and secondary science teacher.

Who Are Some First-Class Black Scientists?

We will consider the stories of some African American scientists whose careers included at least a portion of the Jim Crow Era, in particular 1945–1965 (see Table 1). There are many others who could be discussed, and resources for identifying them can be found at the end of this chapter.

Table 1 African American scientists who worked during the Jim Crow era

Scientist	Gender	Science area	Profession
Archie Alexander	Male	Physical science	Chemist
Austin Curtis	Male	Life science	Biologist
Charles Drew	Male	Life science	Biologist
Katherine Johnson	Female	Earth/space science	Aeronautics mathematician
Carl Rouse	Male	Physical science	Physicist
Marie Maynard Daly	Female	Physical science	Chemist

Scientific Highlights

Before looking at incorporating these should-be-famous scientists into our teacher education courses, we need to know something about them. A brief synopsis of each of the following scientists will be offered here. Included also will be some insights as to how each person overcame numerous societal obstacles and succeeded in her/his chosen profession.

Archie Alexander (1888–1958)

After earning an engineering degree from Iowa University (then called the State University of Iowa) in 1912, Alexander opened his own design firm. This firm designed and built structures encompassing the entire United States, including sewage treatment plants, freeways, and airfields. Most prominently, Alexander was responsible for the Tidal Basin Bridge and Seawall in the United States' capital city, Washington, DC. In his later years, Alexander was appointed Territorial Governor of the Virgin Islands by US President Dwight Eisenhower in 1954. During Alexander's time at Iowa, he faced numerous obstacles because of his race. In fact, he was warned by many of his professors that he would face such challenges as a "Negro engineer," concomitant with the racial prejudices of the 1950s. Alexander was also the first Black football player at his alma mater. Alexander's very successful design firm was a partnership between him and one of his White classmates, Maurice Repass.

Austin Curtis, Jr. (1911–2003)

Curtis is best known as the protégé of Dr. George Washington Carver. Dr. Curtis earned a Ph.D. in chemistry from Cornell University. After this achievement, he completed a fellowship in the laboratory of Dr. Carver in Tuskegee, Alabama, where he collaborated on several projects, including research on peanuts and

sweet potatoes. He was also instrumental in the establishment of the George Washington Carver Cabin in Detroit, Michigan, the G.W. Carver Museum in Tuskegee, and the Carter Research Foundation. Later in life, after Dr. Carter's death, Dr. Curtis moved to Michigan and founded his own company, Curtis Laboratories, and created over 50 natural and organic-based products, several of which were made from peanuts. Although he was Black and living in the southern United States during his most productive years, Curtis was afforded numerous advantages because of his unique affiliation with Dr. Carver. Indeed, in some circles Curtis was referred to as "Baby Carver", carrying with it a certain amount of cachet. This sobriquet afforded Curtis many opportunities to be quite successful in his later years after Carter's death. Thus two Black scientists used their association to benefit themselves and humanity in spite of the racially sensitive times in which they lived.

Charles Drew (1904–1950)

Dr. Drew is well known for his work with the American Red Cross and is known as the "father of blood banks". He earned his medical degree from McGill University in Montreal, Canada. During his lifetime he worked at several hospitals in the United States, even serving as chief surgeon at one. Dr. Drew's short life ended when he and three other doctors were involved in a car accident in North Carolina. Legend has it that needing a blood transfusion, Dr. Drew was denied one at the nearest hospital because he was Black. Lacking the necessary blood to sustain life, Dr. Drew subsequently passed away. While the details of his death are difficult to corroborate because of conflicting reports and accounts, what is clear is because of segregation in the South and other negative activities in the country during the Jim Crow era, these sorts of stories tended to take on mythical status when it came to successful and well-known Blacks. And no one, especially Blacks who were fighting against racist treatment, was going to pass up an opportunity like this story to support their cause.

Katherine Johnson (1918–)

Johnson earned a bachelor's degree in mathematics and French at West Virginia State College. Johnson was the first African American woman to work at the National Aeronautics and Space Administration (NASA) as a research mathematician and physicist. She was based at the Langley Research Center in Hampton, Virginia. Among her numerous accomplishments, Johnson's most remarkable achievement was her contribution to the development of the mathematical method used to keep track of space ships while in orbit. While Johnson's race and gender

could have served as major deterrents to her success as a scientist during the turbulent Civil Rights Era, her knowledge, talent, resourcefulness, and determination proved to be enough to overcome those hurdles. Dr. Johnson continues to serve as a role model for many Black women scientists today.

Carl Rouse (1926–)

Dr. Rouse earned a Ph.D. in physics from the California Institute of Technology (Caltech). Most of Rouse's accomplishments were in the field of astronomy, where he was the *first person* (not first African American!) to solve the Saha equation, a mathematical equation associated with the interior structure of the sun. In 1969, some of Dr. Rouse's solar work was published in the prestigious journal, *Nature*. This was no small achievement, as Black scientists typically worked within communities that associated the value of their work with their skin color. However Rouse was able to accomplish so much because his colleagues in the astrophysics community respected him for his knowledge and scientific acumen.

Marie Maynard Daly (1921–2003)

Dr. Daly was the first Black woman to earn a Ph.D. in chemistry, accomplishing this achievement in 1947 at Columbia University in New York. A native of New York City, Dr. Daly was intimately involved in the early work associated with the organizational structure of DNA. The research she conducted with her colleagues was so well received and regarded that James Watson, Francis Crick, and Maurice Wilkins won a Nobel Prize in 1962, using some of Daly's work to further their understanding of the double-helix structure of the DNA molecule. Dr. Daly was fortunate to colloborate with several White scientists during her illustrious professional career, including her doctoral mentor, Mary L. Caldwell and Dr. A. E. Mirsky, her partner in the study of the cells' nucleus. While it is evident that part of Dr. Daly's success can be attributed to the teamwork that is fairly common in science, it is equally important to highlight that Daly was successful because of her strong working relationships with prominent White scientists. However, Dr. Daly's scientific prowess played just as important of a role in her success.

While the aforementioned biosketches give some sense of the accomplishments of these six amazing scientists, the reader is encouraged to seek more information about each, as their lives were much richer than space allows to be mentioned in this chapter. So now that we know some scientists and their scientific contributions, let us look more closely at the role race played in their lives and how we can situate their accomplishments within the sociocultural times of a portion of the Jim Crow era, 1945–1965.

What Are Some Curricular Connections and Pedagogical Strategies?

The six scientists in the table accomplished much with limited support from the communities in which they lived. Indeed, they succeeded in spite of and not because of such support. Family and key individuals were the nucleus for them, spurring them on to higher heights in their chosen professions.

Much of their adult years were spent during significant civil unrest in the United States. Although citizens, Blacks were subjected to rules and regulations that were not applied to Whites. De jure segregation (i.e., legalized separation) was a natural part of the country's landscape. De facto segregation (e.g., Black people living in a particular neighborhood) also existed, which was just as influential in the scientists' work. Considering the times, we could pose the following questions:

1. How did the Jim Crow laws impact the scientists' recognition in their respective communities and the country?
2. If any one of the six scientists was interviewed today, what would that person highlight as the key factors to her/his scientific success?
3. How might these scientists' lives (both personally and professionally) have been different had Jim Crow laws not been in place during the most productive periods in their careers.

Science teacher candidates should be encouraged (and sometimes forced!) to think about *who* did science, *what* they did in science, *how* they did science, and *why* they did science. Black scientists should be an integral part of the thought process, and it must be an explicit part of teachers' preparation.

Another strategy that could prove fruitful is to role play one of the six scientists. There are many facets of the scientists' lives that are not in view when we focus on their many scientific contributions. For example, focusing on the life of Archie Alexander will cause one to find out more about his relationship with George Washington Carver. Indeed the two scientists spent a significant amount of time together both inside and outside the lab, in a very symbiotic partnership.

A Revisit of the Story of Lee

At the beginning of this chapter, a brief narrative was shared about an experience of a new high school physics teacher facing the challenge of teaching a diverse group of students. Three questions were posed at the end of the story. Questions 1 and 3 should serve as excellent opportunities for preservice science teachers to engage in dialogue about race and its impact on science learning and teaching. If racism is embedded in the US culture, then it truly influenced Lee's major—physics—and his reasons for becoming a physics teacher and not a physicist. Since Lee learned much from his students, how can his students lived experiences be used in his teaching to motivate them to learn science? Are there any racist challenges his students

overcame just to be present in a physics class? These ideas and others can be part of a dialogue in a science teacher education class in which racism and culture are the foci. This part of that discussion should push the preservice teachers to consider the why, what, and how of teaching in culturally diverse science classrooms. Thus, these two questions and their class-generated responses should serve as antecedents to what actually happens in the preservice science classrooms.

Subsequently, Question 2, which queries how university professors could have better prepared Lee for teaching in classrooms with culturally diverse groups of students, now should become of interest to science teacher educators. While prescription is not the objective, Question 2 is most germane to the previous section, for if science teacher educators incorporate these and/or similar ideas that weave sociocultural issues (tied to race) into their teacher preparation programs, their graduates will be at least a modicum better prepared than Lee for working with their students. The success of the teacher and the students necessitates such preparation so that issues that connect race and science are on the forefront of teachers' minds as they seek to prepare students to succeed in a race-conscious society.

Final Thoughts

In this chapter, I set out to enlighten us about African American scientists from the Jim Crow era whose contributions are nationally and internationally significant. In addition, attempts were made to connect the scientists' professional successes with the societal challenges, particularly due to their race, and how they overcame to achieve recognition in science. These and many others like them may have been treated like second-class citizens because of the color of their skin, but they were definitely first-class scientists because of their impact in their respective fields. Their accomplishments and lived experiences can serve as fertile ground for helping teacher candidates understand and appreciate the role history can play in motivating students to want to learn science. Such motivation can serve as the genesis for students to learn the important science knowledge, concepts, and skills they need to succeed in science and in life.

Hopefully, the thoughts and ideas shared in this chapter will whet one's appetite to learn more about these particular scientists and share more strategies for infusing our future middle and high school science teachers with understanding and appreciation for the contributions of these often-overlooked yet phenomenal scientists. They are certainly worthy of celebration.

A Sociocultural Exercise for the Secondary Science Classroom

Over the years, in preparing teacher candidates to teach science, I have used the following assignment to help the preservice teachers think about how they can and should include sociocultural perspectives in their future science classrooms. It has been modified to address the issue of race in the United States.

Cultural Adaptation of a Science Lesson

Using the activities we have done in class as resources and examples, locate a science lesson that you would use in your classroom. It could even be one that you have used with students already. Be sure that the lesson you locate has at least the following components clearly identified:

- Grade level
- Goals and/or objectives
- Materials
- Procedures
- Assessment(s)

If the located lesson does not have the appropriate national and state science standards identified, please include them.

Now, take the identified science lesson and describe how you could modify and/or adapt this lesson to be more socioculturally relevant. In your description, show how you could include issues related to race that are germane to the lesson plan. The maximum length of the description should be three pages. Be sure to include any resources that you would use with the lesson.

Turn in the original lesson as found and the three-page description of your suggested modification(s)/adaptation(s).

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Resources

With the advent of the Internet, there are many sources of information on Black scientists, many of which can provide the context for analyzing science during the integration of the Jim Crow era and the Civil Rights Movement. Be sure to check sources carefully, as legends, myths, and truths can coexist in some of the stories of life.

In addition to the resources cited in the chapter, here are a few more sources of information that could prove useful.

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