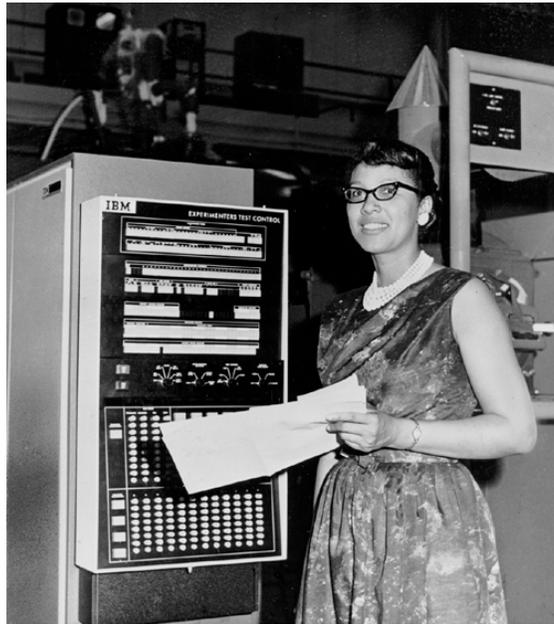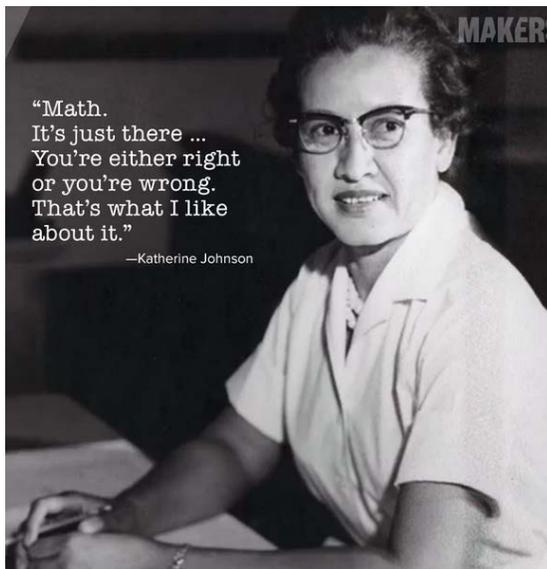# Lesson Plan
"When Computers Wore Skirts:" Katherine Johnson, Christine Darden, and the "West Computers"

Melba Roy Mouton, a computer, in 1960. Mouton was Assistant Chief of Research Programs at NASA's Trajectory and Geodynamics Division and headed the "computers" during the 1960s. Image courtesy of Wikimedia Commons

Katherine Johnson.
Image from MAKERS.

Christine Darden.
Image courtesy of the National Air and Space Museum, Smithsonian Institution.

Grade Level(s): 9-12	Subject(s): History

In-Class Time: 90 min	Prep Time: 15-20 min

Materials

- Photocopies of the AIP West Area Computers Handout
- Access to internet and credible research materials (see Required/Recommended Resources)

Objective

In this lesson plan, students will learn about the "West Computers" or "West Area Computers" – a group of African-American women who worked as "human computers" at NASA Langley Research Center from the 1940s onward. They will also learn about two women in particular – Katherine Johnson and Christine Darden – who started working at NASA as computers and made significant contributions to NASA.

Introduction

Before electronic computers, the term "computers" referred to people rather than machines. "Computers" performed complex mathematical calculations by hand either by themselves or in a group called "computing offices" or "computer pools." The profession originated in the eighteenth and nineteenth century in fields such as astronomy, social science, and ballistics testing where large amounts of data needed to be processed. The growth of "computer pools" occurred rapidly in the interwar period in the United States as preparation for World War II led to large-scale scientific and military research.

The National Advisory Committee on Aeronautics (NACA, the predecessor to NASA) was formed in 1915 during World War I in order to coordinate industry, academic, and government research on war-related projects. Langley Memorial Aeronautical Laboratory, the main research arm of NACA, started hiring computers in the 1930s. The computers of this era were white women who had degrees in mathematics. Because of racial segregation in government, universities, and general society, there were very few opportunities for African American women to obtain employment in federal defense industries or pursue the sciences outside of HBCUs (Historically Black Colleges and Universities).

This began to change starting during World War II. Leading up to the war, A. Philip Randolph, a leader of the Brotherhood of Sleeping Car Porters, began to organize a March on Washington which would demand that the federal government open defense industries to Black workers. In order to stop the March and quell social protest, Roosevelt signed Executive Order 8802 which banned racial discrimination in government defense industries. A shortage of male workers due to the war allowed unprecedented numbers of women and African Americans to enter industries previously restricted to them. It was in this context that the first African American women computers were hired at Langley to compensate for a shortage of male mathematicians. Though the industries were opening to African Americans, segregation continued and Black computers were called the "West Computers" or "West Area Computers" because they were restricted to the West Area of the Langley facility. With their

restrooms, cafeteria, and routes in the building completely separate, many white computers at Langley were actually unaware of the presence of their Black counterparts.

Computers contributed significantly to the success of missions and projects at NASA.   Many computers ended their careers at NASA before the onset of the "Space Age." But for some women, the West Area was a starting point that launched them into long careers in aerospace research at NASA at a time when women were rarely hired as engineers. Katherine Johnson began working at NASA as a research mathematician in 1953. She was a West Area computer for five years before she was temporarily assigned to an all-male, all-white flight research team because of her knowledge of analytical geometry. According to Johnson, she was so successful in her temporary position that her male bosses and colleagues "forgot to return [her] to the pool." She stayed on at the Flight Mechanics Branch and later moved to the Spacecraft Controls Branch. Johnson was working at NASA during an incredibly important time in the history of space science – the "space race" of the Cold War. She calculated the flight trajectory for the space flight which put the first American, Alan Shepard, in space in 1958. She also calculated the trajectory for the famous 1969 Apollo mission to the moon. She worked at NASA until 1985.

Christine Darden was another computer who "left the pool" to become an engineer. Originally from Monroe, North Carolina, Darden graduated from Hampton Institute with a B.S. in Mathematics in 1962. She became a research assistant at Virginia State College in 1965 and began to study aerosol physics and earned her M.S. in Mathematics in 1967. At that time, she was hired as a data analyst at Langley Research Center. Though she started by performing calculations for engineers, she later began writing computer programs and eventually was promoted to the position of aerospace engineer in 1973. She later received her Ph.D. in 1983 from George Washington University in aerospace engineering. In her more than 40-year career, Darden researched sonic boom minimization and served as director of the Program Management Office of the Aerospace Performing Center.

The story of the West Area Computers is rarely told, but it offers an important history of how African American women contributed to the history of space science. Though we sometimes still hear the unfounded stereotype that "girls are bad at math," the story of computers shows that some of the most celebrated scientific achievements relied on the mathematical skills of women of all races. It also allows us to explore how race and gender shaped who was able to pursue and access careers in science. Lastly, because Katherine Johnson and Christine Darden represent successive generations of African American women who worked at NASA as computers, exploring their lives also illuminates historical change at NASA.

Instructions/Activities

1. Divide class into two groups. Each group will be assigned to research either Katherine Johnson or Christine Darden. Additionally, each large group can be broken down into smaller groups that will focus on Johnson and Darden's early life, education, and career. Each student should receive a West Area Computers Handout as a starting point for their research. A list of sources are provided for each individual for research (see Required/Recommended Reading and Resources section).
2. Students should compile their research into a presentation that they can make to the class. After the presentations, broader discussion questions can be used to have a larger class discussion.

Required/Recommended Reading and Resources

Katherine Johnson Resources:
1. An in-depth series of 8 short video interviews on aspects of Katherine Johnson's life: http://www.makers.com/katherine-g-johnson.
2. Jim Hodges, "She Was a Computer When Computers Wore Skirts," NASA, August 26, 2008, http://www.nasa.gov/centers/langley/news/researchernews/rn_kjohnson.html.
3. David Blackwell, "Katherine Johnson: Visionary Videos," National Visionary Leadership Project, http://www.visionaryproject.org/johnsonkatherine.
4. Heather S. Deiss, "Katherine Johnson: A Lifetime of STEM," *NASA Education*, November 6, 2013, http://www.nasa.gov/audience/foreducators/a-lifetime-of-stem.html#.VFetufnF8Vw.
5. "Human Computers: Katherine Johnson," *NASA Biographies*, http://crgis.ndc.nasa.gov/historic/Katherine_Johnson.
6. ScienceMakers Biography of Katherine Johnson: http://www.thehistorymakers.com/biography/katherine-g-johnson-42.
7. ScienceMakers Video Interview Clips:
    a. Katherine Johnson (The HistoryMakers ScienceMakers Video Archive A2012.017), interview by Larry Crowe, 02/06/2012, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 3, story 5, Katherine Johnson talks about her work computing flight trajectories for NASA. http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=6245
    b. Katherine Johnson (The HistoryMakers ScienceMakers Video Archive A2012.017), interview by Larry Crowe, 02/06/2012, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 4, story 1, Katherine Johnson discusses the advent of computers and her work as a mathematician. http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=6249
    c. Katherine Johnson (The HistoryMakers ScienceMakers Video Archive A2012.017), interview by Larry Crowe, 02/06/2012, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 3, story 2, Katherine Johnson describes her experience as a black woman at NASA. http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=6242

Christine Darden Resources:
1. Denise Lineberry, "Standing on the Shoulders of a Computer," NASA, March 29, 2013, http://www.nasa.gov/centers/langley/news/researchernews/rn_CDarden.html.
2. Interview with Christine Darden by Sarah McLennan, April 1, 2011, https://www.youtube.com/watch?v=z_QiI_HESWY.
3. Hilary Mac Austine, "Darden, Christine," *Facts on File Encyclopedia of Black Women in America: Science, Health, and Medicine*, edited by Darlene Clark Hine (New York: Facts On File, 1997), 59.
4. James H. Kessler, J. S. Kidd, Renee A. Kidd, and Katherine A. Morin, *Distinguished African-American Scientists of the 20th Century* (Phoenix, AZ: Oryx Press, 1996), 60-62.
5. Emily McMurray, editor, *Notable Twentieth Century Scientists* (Detroit: Gale Research, 1995), 455-456.
6. Ray Spangenburg and Kit Moser, *African Americans in Science, Math, and Invention* (New York: Facts On File, 2003), 56-58.
7. ScienceMakers Biography of Christine Darden: http://www.thehistorymakers.com/biography/christine-darden.

8. ScienceMakers Video Interview Clips:
   a. Christine Darden (The HistoryMakers ScienceMakers Video Archive A2013.045), interview by Larry Crowe, 02/26/2013, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 4, story 8, Christine Darden talks about being recruited to work at NASA's Langley Research Center in 1967.
   http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=23719
   b. Christine Darden (The HistoryMakers ScienceMakers Video Archive A2013.045), interview by Larry Crowe, 02/26/2013, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 5, story 1, Christine Darden talks about NASA's "West Computers," and segregation at NASA in the 1960s.
   http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=23721
   c. Christine Darden (The HistoryMakers ScienceMakers Video Archive A2013.045), interview by Larry Crowe, 02/26/2013, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 5, story 2, Christine Darden describes her early experience at NASA's Langley Research Center in the 1960s.
   http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=23722
   d. Christine Darden (The HistoryMakers ScienceMakers Video Archive A2013.045), interview by Larry Crowe, 02/26/2013, The HistoryMakers ScienceMakers Video Archive. Session 1, tape 7, story 4, Christine Darden describes her concerns for the African American community and for the current American educational system.
   http://smdigital.thehistorymakers.com/iCoreClient.html#/&i=23739

Discussion Questions

1. Compare Katherine Johnson's and Christine Darden's life and experience at NASA. How were their experiences similar? How were they different?
2. When did electronic computers start being introduced into NASA? What were they like (appearance, size, etc.) and how did people use them?
3. How were Katherine Johnson and Christine Darden recruited to work at NASA? How did they end up leaving the "computer pool"?
4. How was the computer pool organized? How did the computers receive assignments? How did this change over time?
5. What major historical events led to the first African American women being able to work at NASA?
6. What are some of the larger changes that were happening in African American history between when Katherine Johnson started as a computer at NASA in the 1940s and when Christine Darden started in the late-1960s? How would these changes have affected their experiences at NASA?
7. What do you think it would have been like for Johnson and Darden as African American women to work in a predominantly white and male environment as engineers?

Further Reading and Additional Resources

- Margot Lee Shetterly, "Hidden Figures: The African American Women Mathematicians Who Helped NASA and the United States Win the Space Race," http://margotleeshetterly.com/hidden-figures-nasas-african-american-computers/.
  - *Dr. Shetterly is currently working on "The Human Computer Project" which will examine African American women computers at NACA/NASA from the 1930s through the 1970s.*
- Denise Lineberry, "Standing on the Shoulders of a Computer," NASA, March 29, 2013, http://www.nasa.gov/centers/langley/news/researchernews/rn_CDarden.html.
- Sarah McLellon, "'When the Computer Wore a Skirt:' Langley's Human Computers, 1935-1970," NASA, 2011, http://crgis.ndc.nasa.gov/historic/Human_Computers#cite_note-0.
- Jim Hodges, "She Was a Computer When Computers Wore Skirts," NASA, August 26, 2008, http://www.nasa.gov/centers/langley/news/researchernews/rn_kjohnson.html.
- James H. Kessler, et. al., "Christine Mann Darden," *Distinguished African American Scientists of the 20th Century* (Phoenix, Ariz: Oryx Press, 1996), 60-63.
- NASA Biographical profiles of African-American computers:
  - Dorothy Vaughan, head of the West Area Computers. She was one of the first Black women computers hired at NASA (then NACA) in 1943. http://crgis.ndc.nasa.gov/crgis/images/2/29/VaughanBio.pdf
  - Laura Pateman, one of the first Black women hired at NASA in 1948 graduated from Hampton University and was posted in the Rotating Machine Aerodynamics Division. http://crgis.ndc.nasa.gov/crgis/images/2/22/BatemanBio.pdf
- An 18-minute documentary produced by NASA in the 1960s taking the viewer inside the Manned Flight Center and explaining the various functions of different electronic computers. https://www.youtube.com/watch?v=oJPLVa7q410
- "Race and the Space Race" is a one hour radio program narrated by African American astronaut Mae Jemison which focuses on the role that NASA played in civil rights history and the connections between the birth of the Space Age and the struggle for civil rights. http://www.prx.org/pieces/41113-race-and-the-space-race
- Cape Cosmos (http://www.capecosmos.org) is a fictitious space facility set in the 1950s and 1960s. This interactive exhibit allows viewers to explore women and African Americans who contributed to space exploration as scientists and engineers.

Extensions

Additional Resources from the AIP Teacher's Guide on African Americans in Physics, Astronomy, and Related Disciplines:
- Lesson Plans:
  - Meet Four Pioneering African American Astronauts
  - African Americans in Astronomy and Astrophysics

This can be combined with a lesson on scientific notation and solving complex word problems that can introduce students to what it was like to work as a human computer. For example:
- Beacon Learning Center, "Understanding Components of Scientific Notation": http://www.beaconlearningcenter.com/documents/1669_4927.pdf (*This worksheet also includes word problems on the Apollo program that would fit particularly well with this lesson plan.*

Common Core Standards

For more information on Common Core Standards, visit http://www.corestandards.org/.

History/Social Studies	
CCSS.ELA-LITERACY.RH.9-10.1	Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.
CCSS.ELA-LITERACY.RH.9-10.3	Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.
CCSS.ELA-LITERACY.RH.9-10.9	Compare and contrast treatments of the same topic in several primary and secondary sources.
CCSS.ELA-LITERACY.RH.11-12.1	Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
CCSS.ELA-LITERACY.RH.11-12.2	Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
CCSS.ELA-LITERACY.RH.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.RH.11-12.9	Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Next Generation Science Standards

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/.
N/A