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"We will always have STEM with us. Some things will drop out of the public eye and will go away, but there will always be science, engineering and technology. And there will always, always be mathematics."

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# Katherine Johnson: The Girl Who Loved to Count

NASA mathematician, a trailblazer in the quest for racial equality, a contributor to the USA's first triumphs in human spaceflight, and a champion of STEM education, Katherine G. Johnson stands among NASA's most inspirational figures.

**General information:**
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Katherine Johnson was a NASA mathematician who played a key role in several NASA missions during the Space Race, including calculating the trajectory needed to get the Apollo 11 mission to the moon and back. As a black woman working for NASA in the 1950s and '60s, Katherine Johnson overcame social boundaries and racial discrimination.
Johnson was born in 1918 in White Sulphur Springs, West Virginia, the youngest of four children. From a very young age, she had a fascination with numbers, which would lead her to defy all expectations throughout her life.
No one is better than you is the guiding message that her father passed on to her from an early age, emphasizing that the important thing was self-awareness, and being equal to everyone else, regardless of laws or customs.
The parents always lived up to their commitment to education, even when it involved great personal sacrifices: they gave up living on their beloved country farm and moved 120 miles (193 kilometers) away so that their four children could attend the area's only school for black children past eighth grade. Her intense curiosity and brilliance with numbers vaulted her ahead several grades in school. By 13, she was attending the high school on the campus of historically black West Virginia State College. At 18, she enrolled in the college itself, where she quickly worked on the school's math curriculum and found a mentor in math professor William Schieffelin Claytor, the third African American to earn a Ph.D. in mathematics. She graduated with highest honors in 1937 and took a job teaching at a black public school in Virginia. After teaching for a few years, Johnson was accepted to West Virginia University's graduate math program, and in 1939, she became the first black woman to attend the school. However, at the end of the first session, she decided to leave school to start a family with her first husband, James Goble. She

returned to teaching when her three daughters got older. Then, in 1952, a relative told her about an exciting new opportunity: The National Advisory Committee for Aeronautics (NACA) Langley laboratory, the predecessor to NASA, was hiring black women to solve math problems. Johnson applied right away. She was soon hired as a "computer" at the Langley Research Center, tasked with performing and checking calculations for flight tests.
In addition to excelling at her work, Johnson was exceptionally curious and assertive, always questioning her colleagues and asking to be included in important meetings. When she started at NACA, Johnson and her black colleagues were required to work, eat and use restrooms separately from the white employees. But Johnson ignored the racial and gender barriers of the time and became the first woman in the Flight Research Division to be credited as an author of a research report.
In 2015, President Obama awarded Johnson the Presidential Medal of Freedom, America's highest civilian honor. Not bad, for a little girl from West Virginia, who coincidentally (or maybe not) was born on August 26: Women's Equality Day.
Her impressive career was the subject of the 2016 book and movie "Hidden Figures" The release of "Hidden Figures" made Johnson one of the most celebrated black women in space science and a hero for those calling for action against sexism and racism in science and engineering.
Katherine Johnson died on Feb. 24, 2020, at age 101. She was an American hero and her pioneering legacy will never be forgotten.
In 2021 was published "My Remarkable Journey:  A Memoir", the autobiography of the woman who took us to the Moon, the African-American woman with an extraordinary story who crossed difficult racial terrains with the determination necessary to realize a dream and inspire future generations.

**Script for the digital story:**

"You're not worth less than anyone else in this city, but you're not worth more either."
During my childhood I heard dad's words several times and they influenced me deeply. Although during my childhood the law required me to sit in the back of buses, climb into pigeon houses in

theaters, and use drinking fountains and bathrooms reserved for black people, I chose to believe Dad.

"I counted everything. I counted the steps to the road, the steps up to the church, the number of dishes and silverware I washed … anything that could be counted, I did"

"We needed to be assertive as women in those days — assertive and aggressive — and the degree to which we had to be that way depended on where you were. I had to be" (Johnson of her time working for the NACA and later NASA, 1999).

My passion was geometry, useful for calculating the trajectories of spacecraft. For NASA's 1961 Mercury mission, I knew that the trajectory would be a

parabola, a type of symmetrical curve. So when NASA wanted the capsule to come down at a certain place, I was not deterred.

"You tell me when you want it and where you want it to land, and I'll do it backward and tell you when to take off".

“We wrote our own textbook, because there was no other text about space,we just started from what we knew. We had to go back to geometry and figure all of this stuff out. Inasmuch as I was in at the beginning, I was one of those lucky people.”

Subsequent orbital missions were more complicated, with more variables involving the position and rotation of the Earth, so I used a celestial training device to perform my calculations.

I was tasked with calculating the trajectory for Alan Shepard's historic flight, during which he became the first American to reach space. I also confirmed the trajectory to send the first American into orbit around the Earth. By this time, NASA had begun using electronic computers to perform these tasks, but the machines could be a little temperamental. Before his Friendship 7 mission, astronaut John Glenn requested me personally recheck the calculations by hand. "If she says they're good, then I'm ready to go," Glenn said.

The next challenge was to send humans to the moon, and my calculations helped sync the Apollo 11 lunar lander with the moon-orbiting command and service module to get the astronauts back to Earth. I also proved invaluable on the Apollo 13 mission, providing backup procedures that helped ensure the crew's safe return after their craft malfunctioned. I later helped to develop the space shuttle program and Earth Resources satellite.

"Every time engineers would hand me their equations to evaluate, I would do more than what they'd asked. I'd try to think beyond their equations. To ensure that I'd get the answer right, I needed to understand the thinking behind their choices and decisions".
In the 50s "the women did what they were told to do, they didn't ask questions or take the task any further. I asked questions; I wanted to know why. They got used to me asking questions and being the only woman there."
"I didn't want to just do the work, I wanted to know the "hows" and the "whys" and then the "why nots."

"I didn't allow their side-eyes and annoyed looks to intimidate or stop me. I also would persist even if I thought I was being ignored. If I encountered something I didn't understand, I'd just ask. … I just ignored the social customs that told me to stay in my place."

In 1960, I and engineer Ted Skopinski coauthored Determination of Azimuth Angle at Burnout for Placing a Satellite Over a Selected Earth Position, a report laying out the equations describing an orbital spaceflight in which the landing position of the spacecraft is specified. It was the first time a woman in the Flight Research Division had received credit as an author of a research report.
I co-authored 26 research reports before retiring in 1986, after 33 years at Langley.

“I found what I was looking for at Langley. This was what a research mathematician did. I went to work every day for 33 years happy. I loved going to work every single day”.
I spent the following years speaking to students about my extraordinary career, encouraging them to pursue STEM education.
"Some things will drop out of the public eye and will go away. There will always be science, engineering and technology. And there will always, always be mathematics. Everything is physics and math." (NASA Trailblazers and Legends STEM Conference in Cape Canaveral, Florida, 2010).
“Things have to be parallel. I see a picture right now that’s not parallel, so I’m going to go straighten it. Things must be in order.”
"I've always been proud of my work but, my goodness, I didn't do anything on my own"

**Nine lessons from Katherine Johnson**

Lesson 1: No one is better than you.

Lesson 2: Love learning.

Lesson 3: Follow your passion.

Lesson 4: Accept the help you're given and help others when you can.

Lesson 5: Follow new leads and don't give up. Keep trying.

Lesson 6: Ask bold questions. Go beyond the task at hand; be inquisitive. Let yourself be heard.

Lesson 7: Do what you love, and love what you do.

Lesson 8: Don't lose heart.

Lesson 9: Pay it forward and encourage the younger generation.

**Keywords:** Visionary, Passionate, STEM inspirational figure, Race and gender equality Pioneer, Pioneer of scientific citizenship.

**Selected contributions on Katherine Johnson:**

Margot Lee Shetterly: "Hidden Figures", William Morrow and Co., 2016

Katherine Johnson: "Reaching for the Moon", Atheneum Books for Young Readers, 2019.

Katherine Johnson: "My Remarkable Journey. A Memoir", Harper Collins Publishers, 2021

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## Katherine Johnson

**Multiple choice questions**

1) What did Katherine Johnson study at College?
   a) Informatics
   b) Mathematics
   c) Physics
   d) Aerospace Engineering

2) Why did her parents move from West Virginia?
   a) because of the high rents
   b) because her father found a better job somewhere else
   c) because in her home-town she was bullied as she was black
   d) to allow her to attend the high school

3) Katherine Johnson once said, "Everything is physics and mathematics." What does this statement tell us about your worldview?
   a) she was a rational and pragmatic person.

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b) she believed that science and mathematics were the basis for understanding the world.
c) she was a curious person, always looking for new knowledge.
d) All of the above.

4) What makes Katherine Johnson a model of scientific citizenship?

a) To see the work of her research group and all the women who had been computer scientists recognized.
b) Being proud of her work but aware of the importance of belonging to a scientific community.
c) Recognize the merit of sharing one's skills and having created a community of intent that survives the duration of the research carried out.
d) To be recognized as the most capable of the research team.

5) Why can Katherine Johnson be considered the muse for generations of young girls and boys?

a) Because she was a pioneer who broke the barriers of ethnicity and gender.
b) Because it has shown generations of young people that everyone can excel in math and other sciences.
c) Because she had simply done the job she had been hired to do.
d) Because as an African-American she didn't have many job opportunities, but at a certain point she was hired in the agency that would later become NASA and was included in a group of mathematicians.

**Answers**

**What did Katherine Johnson study at the University?**

b) Mathematics

**Why did her parents move from West Virginia?**

d) So she could attend high school

**“Everything is physics and math.” What does this statement tell us?**

d) All of the above

**What makes Katherine Johnson a model of scientific ethics and social contribution?**

c) That she recognizes the value of sharing her knowledge and contributing to the creation of a community with a common purpose, which goes beyond the duration of a single research project

**Why can Katherine Johnson be considered an inspiration for future generations of young girls and boys?**

a) Because she was a pioneer who overcame barriers of race and gender

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# Katherine Johnson

**Discussion questions**

1. Why did Katherine's parents emphasize education? What was the relationship between education and Black citizenship in America in the 30s?
2. Why didn't Katherine complete her math graduate degree? What does this tell you about the intersections of education, employment, gender, and race?
3. How did Katherine handle the racism and sexism she experienced at work?
4. Why was Katherine so eager to work for NACA/NASA? What did the job mean to her?
5. In your opinion, what is the most important lesson that Katherine Johnson left us and why?
6. Katherine Johnson was a pioneer in the fight for racial and gender equality. She was known for her determination and courage. Which of the following actions best exemplifies these qualities?

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• She refused to be segregated from her white colleagues at work, even though she was threatened with termination.
• She was hired as a "computer" at the Langley Research Center, despite NASA's policy of hiring only white men
• She mentored young Black women in STEM fields.
• She calculated the trajectories for the Apollo 11 mission, which landed the first humans on the moon.

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***Katherine Johnson: The Girl Who Loved to Count***

*A NASA mathematician, a pioneer in the fight for racial equality, a contributor to the United States' first human spaceflight successes, and a champion of STEM education, Katherine J. Johnson is one of NASA's most inspiring figures.*

***Read Katherine Johnson's story and complete her empathy map.***

***Can you find any similarities or differences with your own empathy map?***

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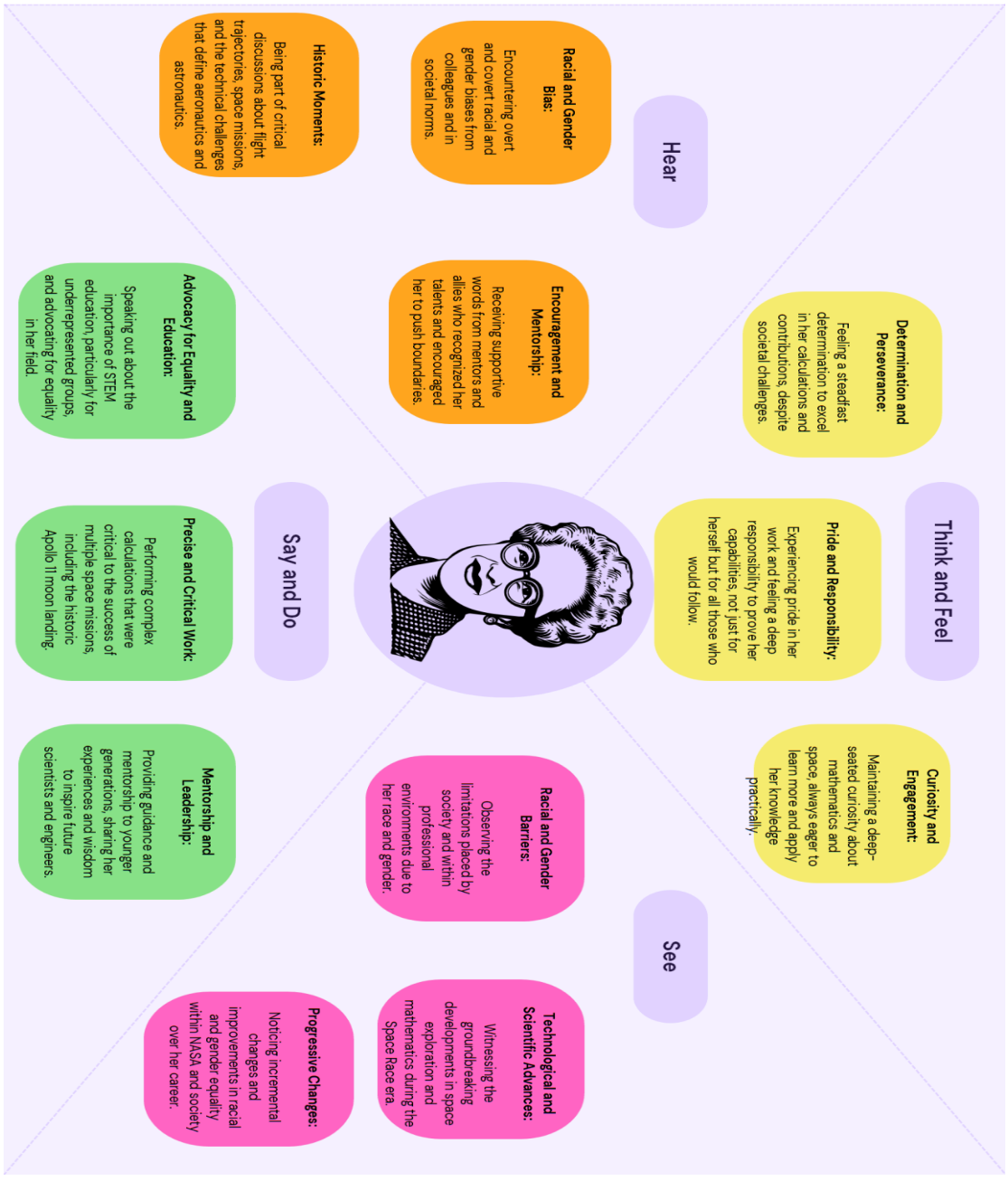


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