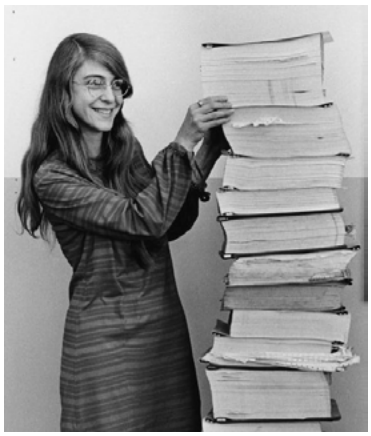
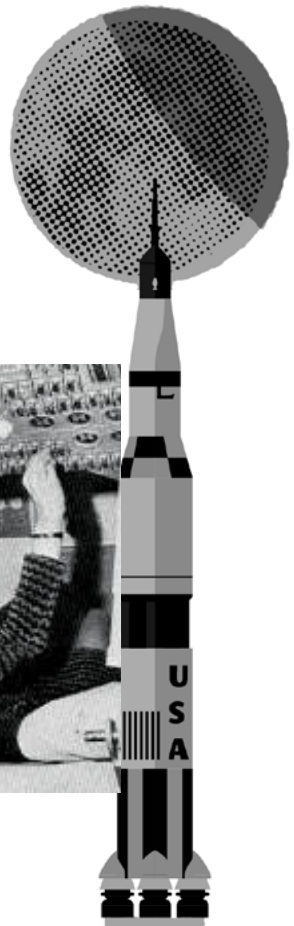
Coding to the Moon:
Margaret Hamilton and the Apollo Missions
STUDY GUIDE





IN COLLABORATION WITH:

Ann Arbor HANDS-ON Museum

Leslie Science & Nature Center

Michigan Science Center

Museum of Natural History, University of Michigan

WITH SUPPORT FROM:

The Buhr Foundation, Detroit Automobile Dealer Association Charitable Fund of the Community Foundation for Southeast Michigan, Ford Motor Company Fund, James A. and Faith Knight Foundation, Michigan Council for Arts and Cultural Affairs, Michigan Humanities, National Endowment for the Humanities, and the National Endowment for the Arts.

Wild Swan Theater

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Young girls need to see role models in whatever career they may choose, just so they can picture themselves doing those jobs someday. You can't be what you can't see. — Sally Ride, First American Woman in Space

Wild Swan Theater's project, *Women Scientists Take the Stage* will introduce young audiences to women who have persisted and contributed to scientific knowledge and understanding. Our overall project goal is to tell stories about women in science that will provide positive role models, challenge stereotypes, and give a more inclusive picture of the nature of scientific work.

The next Mae Jemison, Grace Hopper, or Katherine Johnson may be in our audience and she might be thinking, at even a young age, that math or science is too challenging. The report, "Why So Few? Women in Science, Technology, Engineering, and Mathematics" recommends:

> *Spread the word about girls' and women's achievements in math and science. The more people hear about the achievements of women and girls in math and science, the harder it will be for them to believe the stereotype that boys and men are better than girls and women in these areas.*

The centerpiece of this project is an original production, *Coding to the Moon: Margaret Hamilton and the Apollo Missions*. This production celebrates the brilliant work of a young mathematician and computer scientist who broke new ground as she led the team that built the navigation systems for the missions to the moon. The play is a gripping drama of the daring and risk-taking involved in the lunar missions and how Hamilton's team averted last minute disasters during the flights of Apollo 8 and Apollo 11. The early scenes of the play are set in Michigan's Upper Peninsula where Hamilton spent her childhood; the later scenes at MIT's Instrumentation Lab where Hamilton and her colleagues built and programmed the Apollo Guidance Computer and laid the groundwork for much of today's modern computing.

We are pleased to be collaborating on this project with the Michigan Science Center, Leslie Science and Nature Center, Ann Arbor Hands-On Museum, and University of Michigan Museum of Natural History. Each share our commitment to reaching diverse audiences by offering educational experiences that will complement our production and extend learning about women in science. With the emphasis on STEM education in and out of school, we believe that this project fills an important niche for educators, parents, and youth seeking experiences and resources that expands the views of girls and boys about who works in STEM fields *Coding to the Moon: Margaret Hamilton and the Apollo Missions* provides positive role models, challenges stereotypes, and gives a more inclusive picture of the nature of the STEM/workplace.

OVERVIEW OF PARTNERS

Wild Swan Theater

Wild Swan Theater is dedicated to producing professional theater of the highest artistic quality for families and to making that theater accessible to everyone including low income, minority, and disabled patrons through low ticket prices and innovative outreach programs.

Founded in 1980, Wild Swan Theater has been delighting children and building imaginations with a potent combination of some of the world's greatest stories, original music, dance, masks, puppets, and the visual poetry of American Sign Language (ASL). Since its inception, the company of professional adult actors, dancers, musicians, visual artists, and ASL performers has performed for hundreds of thousands of children in its home base of Ann Arbor and in schools, theaters, museums and public libraries throughout Michigan. Since its founding, Wild Swan has been committed to making theater accessible to all. We have pioneered and sustained an exemplary program to make productions accessible to Deaf, blind, physically impaired, and developmentally disabled children, teens, and adults that has become a state and national model. All the components of Wild Swan productions, scripts, acting, music, and dance, are selected and developed for their outstanding artistry with the belief that children should experience the very best in the arts. Original music is composed for every play and performed live onstage by noted, award-winning musicians. We have presented world premieres of folktales and myths from other cultures such as *Under the African Sky, Marketplace Stories—Folktales from the Arab World, Tales from Egypt* and our bilingual production of Aztec mythology, *Musicians of the Sun.* We have developed historical dramas about women in the World War II workforce in *Rosie the Riveter*, Michigan's maritime heritage in *Shipwrecked!,* the Underground Railroad in *Along the Tracks,* and Native American culture in *Brothers of the Heart.* For more information, please visit www.wildswantheater.org.

Ann Arbor Hands-On Museum and Leslie Science & Nature Center

It all began for AAHOM in 1979 when a group of community volunteers recognized the need for informal science education to supplement formal programs already in the region's schools. They secured the use of the recently vacated Ann Arbor Firehouse (a registered historic structure built in 1882), and began a vigorous fundraising campaign to renovate the first two floors of the building for galleries and classrooms. AAHOM opened to the public in 1982, attracting 25,000 visitors in its first year of operation. Since then, AAHOM has become the cornerstone of informal science education in our community. AAHOM now occupies 40,000 square feet, with 20,000 square feet devoted to exhibit space for 250+ interactive exhibits designed to promote science discovery and literacy.

LSNC got its start after Dr. Eugene and Emily Leslie, who lived in a home surrounded by fields, prairie, and woods and enjoyed having neighborhood children play on their property, wanted to preserve their land for children. They deeded their property to the City of Ann Arbor and, upon their deaths in 1976, the City established Leslie Science Center. In July 2007, Leslie Science Center separated from the City and became Leslie Science & Nature Center— an independent, 501(c)(3) nonprofit organization. This provided the Center with a more sustainable governance structure, yet retained City of Ann Arbor ownership and responsibility for the buildings and grounds. Today LSNC consists of 50 acres of ponds, woods, and prairie and features raptor enclosures, indoor classrooms with live animals, outdoor spaces for play and learning, and an expert staff of interpreters and educators.

For over 30 years, both the Ann Arbor Hands-On Museum (AAHOM) and Leslie Science & Nature Center (LSNC) have been educational anchors of the Southeast Michigan community, providing quality-learning experiences for people of all ages. The mission of the Ann Arbor Hands-On Museum and Leslie Science & Nature Center (LSNC) is to create moments of discovery that inspire curiosity, exploration, and respect for STEM and the natural world. Our Vision is a world where curiosity today leads to more purposeful lives tomorrow. In June 2016, after more than eight years of successful collaborations providing joint-programming, the Ann Arbor Hands-On Museum and Leslie Science & Nature Center took formal steps to unite our organizations, thereby becoming a single provider of science, nature, and environmental education programming. By uniting, our two strong independent entities are building on each other's strengths. This unified organization is able to offer more value to the regional community.

Michigan Science Center

The Michigan Science Center (MiSci) engages curious minds of all ages through science, technology, engineering, and math (STEM). Through hands-on exhibits, educational programming, public programs, and community STEM initiatives, MiSci inspires the imagination, creates life-long impact, and encourages the next generation of innovators and inventors through unique, interactive experiences in STEM. Headquartered in the heart of one of the nation's greatest urban revitalization stories, MiSci opened in December 2012 in downtown Detroit. To date, MiSci has inspired more than 1.6 million people. MiSci's education team produces more than 5,000 hours of innovative programming each year and delivers those programs in a 93,000 square-foot facility that holds 220+ hands-on exhibits, labs, and interactive spaces. The Michigan Science Center's facility and programs have made MiSci a partner of choice to the National Science Foundation and NASA, as well as the world's largest companies like Ford and General Motors. https://www.mi-sci.org/

University of Michigan Museum of Natural History

The University of Michigan Museum of Natural History inspires curiosity through hands-on learning and keeps visitors informed about recent scientific discoveries. Engage with exhibits that explore the natural world — from molecules to dinosaurs — by walking into a giant model cell, touching the rib bone of a real Bristle Mammoth, and more! Identify the diverse ecosystems of Michigan, or locate the distant universe in a state-of-the-art Planetarium & Dome Theater. Learn about ongoing university projects within an active research building by attending the museum's Science Forum presentations and Lab Chats. Then conduct your own experiments in the two child-friendly Investigate Labs. The museum is free for families and individuals. Visit ummnh.org for hours and events.

ABOUT THE APOLLO PROGRAM

Excerpted from:
https://www.nasa.gov/mission_pages/apollo/missions/index.html
https://www.nasa.gov/specials/apollo50th/wehackthemoon.html
https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-was-apollo-program-58.html

What Was the Apollo Program?
Apollo was the NASA program that resulted in American astronauts' making a total of 11 spaceflights and walking on the moon. The first four flights tested the equipment used in the Apollo Program. Six of the other seven flights landed on the moon. The first Apollo flight happened in 1968. The first moon landing took place in 1969. The last moon landing was in 1972. A total of twelve astronauts walked on the moon.

Apollo's Goals
That's one small step for [a] man. One giant leap for mankind.--Neil Armstrong
The national effort that enabled Astronaut Neil Armstrong to speak those words as he stepped onto the lunar surface fulfilled a dream as old as humanity. Project Apollo's goals went beyond landing Americans on the moon and returning them safely to Earth. They included:

- Establishing the technology to meet other national interests in space.
- Achieving preeminence in space for the United States.
- Carrying out a program of scientific exploration of the Moon.
- Developing human capability to work in the lunar environment.

Guiding the Astronauts to the Moon
The twelve astronauts who walked on the Moon are the best-known faces of the Apollo program, but in numbers they were also the smallest part of the program. About 400,000 men and women worked on Apollo, building the vehicles, calculating trajectories, even making and packing food for the crews. Many of them worked on solving a deceptively simple question: how do we guide astronauts to the moon and back safely? The Draper Lab, formerly the MIT Instrumentation Lab, addressed several aspects of that question, including how to develop a computer that could guide a spacecraft on a journey to the moon and then home. In doing so, they helped lead the computing revolution from transistors to integrated circuits and provided NASA with software that worked exactly as it was supposed to every time.

What Spacecraft Were Used for the Apollo Program?
NASA designed the Apollo Command Module for this program. It was a capsule with room for three astronauts. The astronauts rode in the Command Module on the way to the moon and back. It was larger than the spacecraft used in the Mercury and Gemini programs. The astronauts had room to move around inside the spacecraft. The crew area had about as much room as a car.
Another spacecraft, the Lunar Module, was used for landing on the moon. This spacecraft carried astronauts from orbit around the moon to the moon's surface, then back into orbit. It could carry two astronauts.

When Did Humans First Visit the Moon?
The first manned mission to the moon was Apollo 8. It circled around the moon on Christmas Eve in 1968. However, Apollo 8 did not land on the moon. It orbited the moon, then came back to Earth. The crew was Frank Borman, Bill Anders, and Jim Lovell.

The first moon landing occurred on July 20, 1969, on the Apollo 11 mission. The crew of Apollo 11 was Neil Armstrong, Michael Collins, and Buzz Aldrin. Armstrong and Aldrin walked on the lunar surface while Collins remained in orbit around the moon.

Apollo Missions
Saturn Rocket Test Flights
Apollo-Saturn Uncrewed Missions
Apollo 1 Feature Stories | Apollo 1 Mission Overview
Apollo 7 Feature Stories | Apollo 7 Mission Overview
Apollo 8 Feature Stories | Apollo 8 Mission Overview
Apollo 9 Feature Stories | Apollo 9 Mission Overview
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Apollo 17 Feature Stories | Apollo 17 Mission Overview

About Margaret Hamilton

Margaret Heafield was born in 1936 in Paoli, Indiana and graduated from Hancock High School in Michigan's Upper Peninsula. She attended the University of Michigan before graduating from Earlham College with a BA in Mathematics in 1958.

She married James Hamilton after graduation and they moved together to Boston. There she went to work at MIT on software projects (including meteorological software for Edward Lorenz, father of chaos theory, and SAGE system software that searched for enemy airplanes) before landing on the MIT/NASA contract as the lead programmer on the Apollo Guidance Computer. She became the Director of the Software Engineering Division at MIT's Instrumentation Laboratory. She worked on every manned Apollo mission as well as many unmanned missions. For the manned missions, Hamilton led the team that developed the on-board flight software for the command and lunar modules.

Hamilton received the NASA Exceptional Space Act Award (2003) and the Presidential Medal of Freedom awarded by President Barack Obama (2016). She received her own Lego mini-figure in the Women of NASA Lego set in 2017. For over five decades, Hamilton's methods have had a major impact on the field of software engineering up to and including the present day.
(See bibliography for additional print, video, and online resources about Margaret Hamilton)

SUGGESTED ACTIVITIES FOR THE CLASSROOM

1. *We choose to go to the Moon…*

Materials:

- **Video monitor. laptops, or iPads for watching and/or listening to the speech**
- **Video of JFK "We choose to go to the moon…" Speech.** 17:47 minutes. Delivered by President John F. Kennedy on September 12, 1962, Rice Stadium, Rice University, Houston, TX. The video and the entire transcript of the speech (available in 13 languages) is at https://www.jfklibrary.org/learn/about-jfk/historic-speeches/address-at-rice-university-on-the-nations-space-effort
- **Handout #1 – Excerpt from JFK "We choose to go to the moon…" Speech.** Delivered by President John F. Kennedy on September 12, 1962, Rice Stadium, Rice University, Houston, TX
- **Handout #2 – Analyzing Historic Documents "We choose to go to the moon…" Speech.** Delivered by President John F. Kennedy on September 12, 1962, Rice Stadium, Rice University, Houston, TX

Objectives

By participating in this activity, students will:

- Ask the same questions that historians do when examining primary sources to explore and answer questions about the past.
- Develop historical thinking skills by discussing the purpose, point of view, and historical context of a primary source.

Background

When John F. Kennedy was elected President, many Americans were concerned that the U.S. was losing the "Space Race" with the Soviet Union, which had successfully launched the first artificial satellite, Sputnik 1 in 1957. Concerns were deepened when the Soviet Union sent the first human to space with the orbital flight of Yuri Gagarin on April 12, 1961. (They also sent the first woman, Valentina Tereshkova into space on June 16, 1963, with numerous other firsts taking place over the next few years including flight duration, spacewalks, and related activities.)

On May 25, 1961, President Kennedy announced before a special session of Congress his goal to put a man on the moon and return him safely to Earth, before the end of the decade. On September 12, 1962, President Kennedy gave an impassioned speech defending the country's decision to devote resources towards sending a man to the moon by the end of the decade. The speech delivered to an audience of 40,000 (mostly students) at Rice Stadium in Houston was widely reported and quoted.

Twenty years later the astronomer Carl Sagan recalled the audacity and scope of Kennedy's vision this way:

> *We would use rockets that had not yet been designed and alloys not yet conceived, navigation and docking schemes not yet devised, in order to send a man to a world not yet explored even in a preliminary way, even with robots — and we would bring him back, and we would do it before the decade was over. This confident pronouncement was made before any American had achieved earth orbit.*

Procedure

- President Kennedy's "We choose to go to the moon..." Speech was an argument he took to the American public. President Kennedy believed in the power of words. He used words and phrases with the purpose of persuading hearts and minds and moving individuals and nations. This assignment encourages students to analyze this speech and its intent and impact.
- Distribute **Handout #1** Excerpt from "We choose to go to the moon..." Speech. Delivered by President John F. Kennedy on September 12, 1962 Rice Stadium, Rice University, Houston, TX
- Invite students to read it to themselves and then select one or several students to read the excerpt aloud.
- Organize students into small groups and invite them to analyze and discuss the excerpt using **Handout #2.** Students can complete the handout on their own or in small groups.
- Encourage students to define terms, connect the text to prior knowledge, and share observations, ideas, and questions about the speech.
- Invite student to share their observations and analysis to generate discussion about the message and significance of the speech.

Assessment

- Ask students to summarize, in writing or an oral presentation, the central idea of the excerpt and the specific ways, words, or phrases President Kennedy used to inspire, persuade, and appeal to his audience.

Extending Learning Activities

- Visit the "treasure trove," *We Hack the Moon* to learn about the remarkable story of the engineers (including those featured in *Coding to the Moon: Margaret Hamilton and the Apollo Missions*-- Margaret Hamilton, Dan Lickly, George Martin, Phyllis Rye, Ramon Alonso) behind the revolutionary technologies developed for the Apollo missions at the MIT Instrumentation Lab in Cambridge, MA. https://wehackthemoon.com
- Ask students to broaden their perspective by talking with individuals they know about the "race to the moon" and the 1969 lunar landing. Visit the website *Where Were You? Stories of the Most Amazing Day on Earth July 20, 1969* at http://www.wherewereyou.com/
- Invite a Solar System Ambassador to your school or community. These volunteers are happy to share the latest science and discoveries of NASA's missions. https://solarsystem1.jpl.nasa.gov/ssa/home.cfm
- Read full transcript and watch video of the "We choose to go to the moon..." Speech delivered by President John F. Kennedy on September 12, 1962 at Rice University (available in 13 languages) at https://www.jfklibrary.org/learn/about-jfk/historic-speeches/address-at-rice-university-on-the-nations-space-effort

2. *Slipping the Surly Bonds of Earth*...Myth and Poetry

Materials

- **Handout #3 Act I, Scene 3** from *Coding to the Moon: Margaret Hamilton and the Apollo Missions*
- **Suggested poems related to flight, the moon, the night sky, and Apollo 11**
    - ***Moon Catchin' Net*** by Shel Silverstein at http://shelsilverstein.yolasite.com/moon-catchin-net.php
    - ***High Flight*** by John Gillespie Magee at https://nationalpoetryday.co.uk/poem/high-flight/
    - ***The Sweetness of Dogs*** by Mary Oliver at https://wildandpreciouslife0.wordpress.com/2017/08/10/the-sweetness-of-dogs-by-mary-oliver/
    - ***Voyage to the Moon*** by Archibald MacLeish at https://medium.com/poem-of-the-day/archibald-macleish-voyage-to-the-moon-44df49ed19a8

Objectives

By participating in this activity, students will:

- Describe characters in a story and explain how their actions influence events
- Analyze how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision
- Appreciate poetry by listening to its rhyme, rhythm, and overall sound
- Practice reading, writing, expressive, and communicative skills

Background

The Greek myth of Daedalus and Icarus flying using wings made of feathers, wax, and twine is told to Margaret by her father in *Coding to the Moon: Margaret Hamilton and the Apollo Missions.* Told and re-told for centuries it is one of the most beloved myths that reflect the dreams of human-powered flight. Almost every culture has its own version of stories of soaring gods and flying heroes, winged horses and dragons, as well as flying carpets and chariots. For centuries, the themes of flight, the night sky, the moon, and space exploration have been a source of inspiration for a diverse array of poets, playwrights, authors, and storytellers.

Reader's theater is a way to involve students in reading aloud by having them "perform" by reading from a script. "Making theater" in the classroom can develop creativity, curiosity, communication, empathy, and cooperation. Drama is ideal for cross-curricular learning and is a valuable tool for developing language arts skills of writing, speaking, listening, and viewing.

Glossary

Haiku – Haiku is a form of Japanese poetry consisting of 17 syllables in three verses.
The first and third lines have five syllables, and the second has seven syllables.
Acrostic – An acrostic poem is one in which a word or phrase is spelled out vertically using a letter from each line.

Procedure

- Distribute **Handout** #3 and select students to portray Margaret Hamilton and her father
- Give the readers the opportunity to read the script silently to themselves. Invite them to read their parts from the script aloud and act it out.
- Encourage students to analyze and reflect on the characters, setting, and story for the selected scene. Invite students to describe what is happening by asking:
    - Who are the characters in the scene?
    - Where do you think the scene takes place?
    - Describe what is happening in the scene?
    - What characteristics or traits do the characters have?
    - How would you describe each character's feelings?
    - What story does her father share with her? Why do you think he tells this story?
    - What do you learn about Margaret Hamilton from this scene? How would you describe Margaret as a child? (curious, inquisitive, likes the outdoors, persistent, fascinated with the stars and the moon, interested in flying, likes stories, observer of nature, etc.)
- Ask students to share stories, myths, poems, or songs they have heard or know about the themes of flight, the night sky, the moon, and space exploration.
- Select one of the suggested poems *Moon Catchin' Net* by Shel Silverstein, *High Flight* by John Gillespie Magee, *The Sweetness of Dogs* by Mary Oliver, or *Voyage to the Moon* by Archibald MacLeish or one of your own choosing that relates to themes of flight, the night sky, the moon, and space exploration.
- Preview the selected poem and read it aloud or choose students to read it aloud. By reading the poem aloud a few times student get a better feel for the language, rhyme, and rhythm of the poem.
- Discuss and define unfamiliar word or phrases in the poem.
- Invite student to visualize the poem or imagine the picture being painted by the poet. Encourage students to draw or write about what they imagine the poem to be describing

Assessment

- Provide students with the opportunity to further explore the themes of flight, the night sky, the moon, and space exploration, through additional images, videos, websites, stories, poems, and myths. For example, they could visit the *NASA Image and Video Gallery* https://images.nasa.gov/ or *We Hack the Moon* at https://wehackthemoon.com/
- Give students the opportunity to write their own poem inspired by themes of flight, the night sky, the moon, and space exploration, providing support as necessary. Or, work as a class to create a haiku or acrostic.

Extending Learning Activities

- After watching the play, *Coding to the Moon: Margaret Hamilton and the Apollo Missions,* initiate discussion by asking:
    - What surprised them?
    - What did they learn about Margaret Hamilton?
    - What additional questions do they have about Margaret Hamilton?

Individually or as a class, compose a letter to Margaret Hamilton with your questions and comments. Send to Wild Swan Theater, 6175 Jackson Road, Ann Arbor, MI 48103. Letters collected will be shared with Margaret Hamilton.

3. Why So Few? STEM and the Gender Gap

Materials

- **Handout #4 *Closing the STEM Gap: Why STEM classes and careers still lack girls***

Objectives

By participating in this activity, students will:

- Use a variety of resources (e.g., libraries, databases, computer networks, video) to explore and research a woman from history and identify her key accomplishments
- Discuss how messages about male/female roles and stereotypes are transmitted and reinforced
- Consider how actions and images can shape public perception and perpetuate bias

Background

Nationally, and in Michigan, the demand for a skilled STEM workforce is growing and STEM jobs offer higher salaries than non-STEM jobs.[1] Women working in STEM jobs earn, on average, 35 percent more than those in other fields, yet women account for only 24 percent of the STEM workforce.[2] In Michigan, women earn more than 50 percent of two-year and four-year degrees[3], but only a third of Michigan graduates in STEM are women.[4] Women's under-representation in STEM fields starts early, with gender gaps in STEM interests beginning in middle school and growing throughout high school, college, and career. Far too many girls and women are discouraged from pursuing success in STEM fields. Now is the time for change.

The report, *Why So Few? Women in Science, Technology, Engineering, and Mathematics* recommends that because of the disparity between the numbers of men and women in these fields, schools, educators, and parents must:

> *Spread the word about girls' and women's achievements in math and science. The more people hear about the achievements of women and girls in math and science, the harder it will be for them to believe the stereotype that boys and men are better than girls and women in these areas.*

Altering perceptions requires expanding the views of girls and boys about who works in STEM fields. Margot Lee Shetterly, author of *Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*, emphasizes the importance of showcasing women in science for storytellers like Wild Swan Theater,

> *Reviewing them and pulling them out of the shadows creates a more complete and nuanced view of history...It's one thing to read something and then to see it come to life.*

Bringing women in science stories to life can be one strategy for breaking down the barriers facing girls and women in science.

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1 Rothwell, J. (2013). The Hidden STEM Economy. The Brookings Institute. Accessed on November 23, 2019 from https://www.brookings.edu/research/the-hidden-stem-economy/

2 Noonan, Ryan. Office of the Chief Economist, Economics and Statistics Administration, U.S. Department of Commerce. (November 13, 2017). Women in STEM: 2017 Update (ESA Issue Brief #06-17). Retrieved from https://www.esa.gov/reports/women-stem-2017-update.

3 MI School Data. Retrieved from https://www.mischooldata.org/CareerAndCollegeReadiness2/CollegeDegreesandCertificatesAwarded.aspx?Common_Locations=1-A,0,0,0~201-E,0,0,0~202-E,0,0,0&Common_SchoolYear=&Common_LocationIncludeComparison=False&Common_IheType=None&Portalhttps://www.mischooldata.org/CareerAndCollegeReadiness2/CollegeDegreesandCertificatesAwarded.aspx?Common_Locations=1-A,0,0,0~201-E,0,0,0~202-E,0,0,0&Common_SchoolYear=&Common_LocationIncludeComparison=False&Common_IheType=None&Portal_InquiryDisplayType=Snapshot&Common_Subgroup_IheEnrollmentByIhe=All&Common_IheEnrollmentDimension=None

MI School Data_InquiryDisplayType=Snapshot&Common_Subgroup_IheEnrollmentByIhe=All&Common_IheEnrollmentDimension=None

4 MI School Data

Glossary

- Gender Gap -- the discrepancy in opportunities, status, attitudes, etc., between men and women.
- Role Model -- a person looked to by others as an example to be imitated.
- STEM -- an acronym for the fields of science technology, engineering and math. Many educators and organizations have added arts to STEM, resulting in the acronym STEAM.
- Stereotype -- to believe unfairly that all people or things with a particular characteristic are the same
- Bias -- prejudice in favor of or against one thing, person, or group compared with another, usually in a way considered to be unfair.

Procedure

- Prompt a class discussion about a great woman in science role model by inviting students to brainstorm what they know about Sally Ride:
    - Who was she?
    - What were her accomplishments?
    - In what ways did she make a difference?
    - Where have you learned about her? What more would you like to know about her? Where would you go for additional information?
- Share with students the following quote attributed to Sally Ride: *Young girls need to see role models in whatever career they may choose, just so they can picture themselves doing those jobs someday. You can't be what you can't see.*
- Ask student to respond to this quote by asking:
    - What point is she trying to make?
    - Why do you think this would be important to her? In what ways is Sally Ride a role model? How many other women role models can you identify?
    - Are there occupations that you associate with men more than women? Why?
    - Are there occupations that you associate with women more than men? Why?
    - Do you think you are more likely to consider jobs or careers if you see people like you performing them? Why or why not?
- Copy, share, and read aloud **Handout #4** *Closing the STEM Gap: Why STEM classes and careers still lack girls*
    - What does STEM stand for?
    - What facts are including in the Background sections? Did any surprise you?
    - What were some of the findings or discoveries described in the Insights section? Did any surprise you? What did not surprise you?
    - Can you provide your own examples of being encouraged or discouraged from thinking about taking science, math, or computer classes?
    - How did these experiences affect your interest in these classes?
    - What do you think are the biggest obstacles encountered by young people interested in STEM classes or careers?
    - What strategies are suggested in the Strategies section for encouraging interest in STEM classes or careers?
    - What do you think would be the most effective? Why?
    - What would you tell the writers of this report as to why STEM and careers lack girls?
    - What strategies would spark or encourage your interest in STEM classes or careers?

- Ask students to broaden their perspective about women and girls in STEM classes or careers by talking to women they know--grandmothers, mothers, aunts, sisters, neighbors, etc.--about women in today's schools or workplaces and have them ask questions such as:
    - What do they think has changed for women in today's workplace? What do they think has stayed the same?
    - What were some of the obstacles encountered? What were some of the obstacles overcome?
    - What advice do they have for girls considering STEM classes or careers?

Assessment

- Invite students to explore, research, and present a short report on a woman in science from the past or present. Share with students resources about Margaret Hamilton or other women in science from the Bibliography. The report or presentation can include aspects of their life such as childhood, education, hobbies/passions, major accomplishments, etc.

Extending Learning Activities

- Contact local museums or organizations listed in the Bibliography to visit their sites or to arrange for classroom visits of women to learn more about working in the STEM fields.
- Using resources suggested in the Bibliography to learn more about gender bias in classrooms and teaching materials. Prepare a report with your findings and recommended changes for creating a more equitable learning environment for all students? Or conduct a gender equity audit of biographies of individuals in STEM fields in your classroom or school library to assess the balance or imbalance of women and men represented. Pending the results of your survey, develop some strategies for addressing an imbalance, if it exists.
- Continue examination of the media today and the portrayal of women in STEM careers. Discuss a seven-year-old Charlotte Benjamin's hand-written letter scolding Lego for what she saw as gender stereotypes in their toys,"...all the girls did was sit at home, got to the beach, and shop, and had no jobs," while the boy figures "went on adventures, worked, saved people, and had jobs," adding they "even swam with sharks". In her January 25, 2014 letter, she asks the company to "make more Lego girl people and let them go on adventures and have fun ok!?! Thank you." Ask students if they can think of other instances where girls are underrepresented or mis-represented in the media, toys, careers, etc.? Brainstorm strategies for addressing these issues. Students can produce essays, group presentations, collages and other works to explore and discuss these topics.

ANNOTATED BIBLIOGRAPHY
Selected Print, Video, Online, and Local Resources

Margaret Hamilton

- DiPiazza, Domenica. ***Space Engineer and Scientist Margaret Hamilton.*** (STEM Trailblazer Bios) New York: Lerner Classroom, 2017. As a girl, Hamilton loved math and science. She grew up during a time when very few women studied computer science, but Hamilton knew she wanted to write code. As an adult, she worked on NASA's Apollo program, creating computer programs to guide spacecraft to and from the moon. For 7-11 years.
- Robbins, Dean (author) and Knisley, Lucy (illustrator). ***Margaret and the Moon: How Margaret Hamilton Saved the First Lunar Landing.*** New York: Knopf Books for Young Readers, 2017. Margaret Hamilton loved numbers as a young girl. She knew how many miles it was to the moon. She loved studying algebra, geometry, calculus, and using math to solve problems in the outside world. Soon math led her to MIT and then to helping NASA put a man on the moon! For 4 - 8 years.
- ***Margaret Hamilton, NASA's First Software Engineer.*** Excellent 4:41 minute video of Hamilton discusses joining NASA as their first software engineer and creating the software that launched the Apollo 11 first manned mission to the moon. https://www.yahoo.com/lifestyle/margaret-hamilton-nasas-first-software-005827531.html
- ***Her Apollo Code Saved The Moon Landing...Meet Computer Scientist, Margaret Hamilton*** from Women You Should Know, May 17, 2016. Includes a 4:35 minute video. https://womenyoushouldknow.net/her-apollo-code-saved-the-moon-landing-meet-computer-scientist-margaret-hamilton/
- ***Margaret Hamilton: MIT Software Pioneer Who Helped Save Apollo 11 Moon Mission***, June 28, 2019. CBS News article with 1:53 minute video. https://boston.cbslocal.com/2019/06/28/margaret-hamilton-apollo-11-software-pioneer-interview/
- ***Margaret Hamilton—2017 Computer History Museum Fellow***. 6:27 minute video interview with Hamilton who was honored by the Computer History Museum for her leadership and work on software for Department of Defense and NASA's Apollo space missions and for fundamental contributions to software engineering. https://www.youtube.com/watch?v=4sKY6_nBLG0
- ***Scene at MIT: Margaret Hamilton's Apollo Code: A brief history of the famous 1969 photo of the software that sent humans to the moon.*** By Maia Weinstock, *MIT News Office*, August 17, 2016. http://news.mit.edu/2016/scene-at-mit-margaret-hamilton-apollo-code-0817
- ***Margaret Hamilton: The Untold Story of the Woman Who Took Us to the Moon: Meet the woman who made Apollo 11 and our trip to the Moon possible.*** By Jolene Creighton, *Futurism,* July 20, 2016. https://futurism.com/margaret-hamilton-the-untold-story-of-the-woman-who-took-us-to-the-moon
- ***Margaret Hamilton: 'They worried that the men might rebel. They didn't.'*** By Zoe Corbyn, *The Guardian,* July 13, 2019. Interview with Margaret Hamilton. https://www.theguardian.com/technology/2019/jul/13/margaret-hamilton-computer-scientist-interview-software-apollo-missions-1969-moon-landing-nasa-women
- ***Margaret Hamilton Led the NASA Software Team That Landed Astronauts on the Moon.*** By Alice George, Smithsonian.com, March 14, 2019. https://www.smithsonianmag.com/smithsonian-institution/margaret-hamilton-led-nasa-software-team-landed-astronauts-moon-180971575
- *Margaret Hamilton Tribute*. Google unveiled a giant tribute to Hamilton in California's Mojave Desert: More than 107,000 mirrors were positioned to reflect moonlight and form her image for one night. https://www.cnn.com/2019/07/19/us/apollo-11-margaret-hamilton-50th-anniversary-trnd/index.html

Coding

- **Digerati Girls** Digerati Girls is the brainchild of Detroit entrepreneur and Venture capitalist, Monica Wheat, and aims to increase the number of women and girls pursuing digital careers. http://www.digeratigirls.com/newsite/
- **Girls Who Code** Girls Who Code is on a mission to close the gender gap in technology and to change the image of what a programmer looks like and does. Website lists programs, events, and resources. https://girlswhocode.com/
- **TED Talk by Reshma Saujani, Founder of Girls Who Code** https://www.ted.com/talks/reshma_saujani_teach_girls_bravery_not_perfection?language=en
- **Black Girls Code** Black Girls Code is committed to increasing the number of women of color in the digital space by empowering girls of color ages 7 to 17 to become innovators in STEM fields, leaders in their communities, and builders of their own futures through exposure to computer science and technology. http://www.blackgirlscode.com/
- **Code.org** is a nonprofit dedicated to expanding access to computer science in schools and increasing participation by women and underrepresented minorities. Code.org also organizes the annual Hour of Code campaign that has engaged 15% of all students in the world. https://code.org/
- ***A Mighty Girl Website.*** Women in science resources are extensive at https://www.amightygirl.com/books/general-interest/science-technology and include:
    - ***Girls Who Code: Learn to Code and Change the World*** Written by Reshma Saujani The non-profit **Girls Who Code** has taught over 40,000 girls to code! This inspiring book is full of exciting illustrations and accessible explanations of coding principles. Real-life stories of girls and women in programming will show you the incredible range of careers and possibilities that coding provides, while information about the next steps you can take will get you ready to jump into your coding adventure Recommended Age: 9 and up
    - ***Women Who Launched The Computer Age*** Written by: Laurie Calkhoven Illustrated by: Alyssa Petersen Meet the women who programmed the first all-electronic computer and built the technological language kids today can't live! In 1946, six brilliant young women programmed the first all-electronic, programmable computer, the ENIAC, part of a secret World War II project. They learned to program without any programming languages or tools, and by the time they were finished, the ENIAC could run a complicated calculus equation in seconds. However, when the ENIAC was presented to the press and public, the women were never introduced or given credit for their work. Learn all about what they did and how their invention still matters today in this story of six amazing young women everyone should meet! Recommended Age: 6 - 8
- ***Beanz: The Magazine for Kids, Code, and Computer Science*** *Beanz* is a bi-monthly magazine published 6 times a year; the magazine explores computer science and software programming. It's for kids, parents, teachers, and adults who want to learn and have fun with technology. https://www.kidscodecs.com/
- ***42 Best Classes to Learn to Code for Free in 2020*** by Chris Castiglione, March 4, 2019. Want to learn to code? There are plenty of free online coding classes. Use this list of 42 free coding courses to learn how to code in 2020. https://learn.onemonth.com/42-best-classes-to-learn-to-code-for-free/

Women in Science

- Acevedo, Sylvia. ***Path to the Stars: My Journey from Girl Scout to Rocket Scientist***. New York: Clarion Books, 2018. This inspiring memoir for young readers about a Latina rocket scientist whose early life was transformed by joining the Girl Scouts and who currently serves as CEO of the Girl Scouts of the USA.
- Hanna-Attisha, Mona. ***What the Eyes Don't See: A Story of Crisis, Resistance, and Hope in an American City*** New York: One World, 2018. The inspiring story of how Dr. Mona Hanna-Attisha, alongside a team of researchers, parents, friends, and community leaders, discovered that the children of Flint, Michigan, were being exposed to lead in their tap water—and then battled her own government and a brutal backlash to expose that truth to the world.
- ***Women Who Shaped Science*** shares the stories of women scientists who also changed the world, but were written out of history. These pioneers paved the way for future generations of women scientists and explorers. https://www.smithsonianmag.com/science-nature/women-science-180967866
- ***The Untold History of Women in Science and Technology*** Listen to women from across the Administration tell the stories of their personal heroes across the fields of science, technology, engineering, and math (STEM). https://obamawhitehouse.archives.gov/women-in-stem
- ***A Mighty Girl Website.*** More women in science resources at https://www.amightygirl.com/books/general-interest/science-technology and include:
    - ***Headstrong: 52 Women Who Changed Science — And The World*** Written by: Rachel Swaby For every famous name like Marie Curie and Jane Goodall, there are dozens or hundreds of women whose work in science is little known — and even when it is, their contributions are often minimized or forgotten. Within it, she provides capsule biographies of 52 women scientists whose stories need to be told. Recommended Age: 13+
    - ***Women in Science: 50 Fearless Pioneers Who Changed the World*** Written by: Rachel Ignotofsky This charmingly illustrated and educational book highlights the contributions of fifty notable women to the fields of science, technology, engineering, and mathematics from the ancient to the modern world. Recommended Age: 9+
- ***Women at NASA*** Through their accomplishments and dedication to their jobs, women at NASA embody the essence of Women's History Month. They serve as role models to young women in their pursuit of careers in science, technology, engineering and mathematics. https://www.nasa.gov/stem/womenstem.html#.VhmGv6KgoeK

STEM and the Gender Gap

- ***Making a Difference for Girls in STEM*** by Microsoft. To help close the gender gap in Science, Technology, Engineering, and Math (STEM) we must all take action and inspire girls to #MakeWhatsNext. Closing the gap requires tapping into girls' creativity, providing encouragement, and connecting STEM subjects to real-world examples. Includes an action guide to help close the STEM gap. https://www.microsoft.com/en-us/corporate-responsibility/skills-employability/girls-stem-computer-science on their lives.
- ***Keeping Girls in STEM: 3 Barriers, 3 Solutions.*** By Carly Berwick, March 12, 2019. Stereotypes and cultural norms dampen girls' interest in STEM, but educators can counter the disparities with small changes to their practice. https://www.edutopia.org/article/keeping-girls-stem-3-barriers-3-solutions
- ***The STEM Gender Gap: Can Science Attract Women.*** By Stephen Ornes. Women lag far behind men as a share of the workforce in most science, technology, engineering and math (STEM) professions, even as demand for those skills increases in order to help the United States remain globally competitive. http://library.cqpress.com/cqresearcher/document.php?id=cqresrre2018090700

- ***Generation STEM--What Girls Say About Science, Technology, Engineering, and Math.*** by Girl Scouts of the USA, 2012. The goal of the Girl Scout Research Institute (GSRI) is to elevate the voices of girls on issues that matter to them and their futures. The aim of this report is to explore how girls can better become engaged in STEM through examination of what girls themselves say are their interests and perceptions about these important fields. https://www.girlscouts.org/join/educators/generation_stem_full_report.pdf
- ***NSTA Position Statement--Gender Equity in Science Education*** The National Science Teaching Association (NSTA) strongly asserts that gender equity is critical to the advancement of science and to the achievement of global scientific literacy. https://www.nsta.org/about/positions/genderequity.aspx

Lesson Plans

- ***Let's Launch!*** For Grades 5-8, Let's Launch! is Challenger Center's first Flipped Classroom series. Join Maya and her friend B.U.D as they learn about planetary science – Mars, the Sun, Near-Earth Objects, the Moon, and the Solar System. Each course includes an 8-10-minute animated video accompanied by three lesson plans for use in the classroom. https://www.challenger.org/challenger_lessons/letslaunch/
- ***Next Giant Leap*** For Grades 3-9 (can be adapted for all ages)The Next Giant Leap takes students through seven phases of a Lunar Exploration: preparing for launch, rocket launching, lunar landing, the Moon phases, lunar geology, lava tube exploration, and programming a lunar rover. https://www.challenger.org/challenger_lessons/the-next-giant-leap/
- ***Planetary Poetry*** STEM concepts are ripe with opportunity for English language arts (ELA) integration. This lesson provides guidance and examples for using NASA missions and discoveries to get students writing poems to share their knowledge of or inspiration about these topics. https://www.jpl.nasa.gov/edu/teach/activity/planetary-poetry/
- ***Women in Tech Lesson Plans*** Free download of *Women in Tech Lesson Plans* and classroom posters of women in technology! Students will explore hidden history of women in tech whose stories are central to the field of computer science, discuss computer science's impact on the world, and uncover how they already think like a computer scientist. https://girlswhocode.com/women-in-tech-lessonplans/
- ***How Outstanding Women in STEM Fields Overcame Obstacles.*** This lesson explores the careers of 19 great female scientists, the obstacles they overcame and asks students to look at their own schools, teachers, friends and families to see whether those obstacles continue to operate in their lives.https://www.pbs.org/newshour/extra/lessons-plans/how-outstanding-women-in-stem-fields-overcame-obstacles-lesson-plan/
- ***Girls and Women in STEM*** from the Smithsonian Science Education Center. This site is designed to provide STEM resources for all students–girls and boys. https://ssec.si.edu/girls-and-women-in-stem
- ***Science NetLinks Women's History Collection*** A one-stop collection of videos, booklets, and websites you can use for lessons plans that honor women pioneers in STEM disciplines throughout history and today.
- ***Toys and Gender*** This lesson will give students the opportunity to learn about and reflect on how toys are influenced by gender stereotypes and how children and their families are impacted by those messages. Can be easily adapted for older students. https://www.adl.org/sites/default/files/documents/assets/pdf/education-outreach/toys-and-gender.pdf

Local Resources

- **Ann Arbor Hands-On Museum** https://www.aahom.org/
- **Leslie Science & Nature Center** https://www.lesliesnc.org/
- **University of Michigan Museum of Natural History** https://lsa.umich.edu/ummnh/
- **Yankee Air Museum** https://yankeeairmuseum.org/
- **Michigan Science Center** https://mi-sci.org/
- **The STEMinista Project** The STEMinista Project is for girls in 4th–8th grade and offers special opportunities in STEM with girls in mind. There are cool programs, special Michigan Science Center days, meet-and-greets with women who have interesting STEM jobs, and much more! https://www.mi-sci.org/steminista-project/the-steminista-project-signup/
- **MSU Science Festival** The 8th annual MSU Science Festival will take place April 1-30, 2020. Its mission is to celebrate the many ways science, technology, engineering, art, and mathematics (the STEAM disciplines) touch our everyday lives and shape our future, broaden public access to informal learning environments, create meaningful direct interactions with scientists, and inspire the workforce of the future. https://sciencefestival.msu.edu/
- **Girl Scouts of Southeast Michigan and Girl Scouts Heart of Michigan**. Girl Scouts now offers a STEM badge! https://www.gssem.org/ and https://www.gshom.org/
- **U-M WISE** U-M WISE programming encourages and supports all students from pre-college (grades 6-12) through undergraduates and graduate students. Programs are designed for women and girls but open to students of any gender identity. https://lsa.umich.edu/wise
- **F.E.M.M.E.S.** Through engaging, hands-on activities presented in a fun, supportive environment, F.E.M.M.E.S. programs encourage girls to learn and explore their potential in science, technology, math and engineering (STEM). https://www.femmes.studentorgs.umich.edu/

RELATED MICHIGAN CONTENT STANDARDS

Social Studies Standards
Reading and Communications
P1.1 Use appropriate strategies to read and analyze social science tables, graphs, graphics, maps, and texts.
P1.2 Interpret primary and secondary source documents for point of view, context, bias, and frame of reference or perspective.
Inquiry, Research, and Analysis
P2.1 Apply methods of inquiry, including asking and answering compelling and supporting questions, to investigate social science problems.
P2.2 Evaluate data presented in social science tables, graphs, graphics, maps, and texts for credibility, considering the origin, authority, structure, and context of the information.
P2.3 Know how to find, organize, evaluate, and interpret information from a variety of credible sources.
USHG ERA 8 – Post World War II United States (1945-1989)
8.1 Cold War and the United States 2

English Language Arts Standards
- Reading Narrative Text
- Reading Comprehension
- Reading Attitude
- Writing
- Speaking Discourse
- Listening and Viewing Conventions
- Listening and Viewing Response

Arts Education Standards
Arts Education – Theater
1. Perform
2. Create
3. Analyze
4. Analyze in Context
5. Analyze and Make Connections

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MUSEUM PARTNERS

Ann Arbor HANDS-ON Museum
Leslie SCIENCE & NATURE Center
MICHIGAN Science CENTER
MUSEUM OF NATURAL HISTORY UNIVERSITY OF MICHIGAN

Handout #1 – Excerpt from *We choose to go to the moon*...Speech. Delivered by President John F. Kennedy on September 12, 1962 Rice Stadium, Rice University, Houston, TX

Those who came before us made certain that this country rode the first waves of the industrial revolutions, the first waves of modern invention, and the first wave of nuclear power, and this generation does not intend to founder in the backwash of the coming age of space. We mean to be a part of it--we mean to lead it. For the eyes of the world now look into space, to the moon and to the planets beyond, and we have vowed that we shall not see it governed by a hostile flag of conquest, but by a banner of freedom and peace. We have vowed that we shall not see space filled with weapons of mass destruction, but with instruments of knowledge and understanding.

Yet the vows of this Nation can only be fulfilled if we in this Nation are first, and, therefore, we intend to be first. In short, our leadership in science and in industry, our hopes for peace and security, our obligations to ourselves as well as others, all require us to make this effort, to solve these mysteries, to solve them for the good of all men, and to become the world's leading space-faring nation.

We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of pre-eminence can we help decide whether this new ocean will be a sea of peace or a new terrifying theater of war. I do not say the we should or will go unprotected against the hostile misuse of space any more than we go unprotected against the hostile use of land or sea, but I do say that space can be explored and mastered without feeding the fires of war, without repeating the mistakes that man has made in extending his writ around this globe of ours.

There is no strife, no prejudice, no national conflict in outer space as yet. Its hazards are hostile to us all. Its conquest deserves the best of all mankind, and its opportunity for peaceful cooperation many never come again. But why, some say, the moon? Why choose this as our goal? And they may well ask why climb the highest mountain? Why, 35 years ago, fly the Atlantic? Why does Rice play Texas?

We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.

It is for these reasons that I regard the decision last year to shift our efforts in space from low to high gear as among the most important decisions that will be made during my incumbency in the office of the Presidency.

Handout #2 – Analyzing Historic Documents
Excerpt from *We choose to go to the moon*... Speech.

- Delivered by:
- When and where was this speech delivered?
- Who was the audience?
- What messages or ideas do you think President Kennedy wanted to communicate?
- Summarize what you learned from the speech?
- What was happening at the time in history he gave this speech?
- What do you think was the purpose of this speech?
- What are some of the ways that President Kennedy is informing, persuading, or entertaining the listener?
- After reading or listening to this speech, what questions do you have?
- How would you find the answers to your questions?

Handout #3 – Act I, Scene 3 from *Coding to the Moon: Margaret Hamilton and the Apollo Missions*

(NIGHT SKY OF STARS AND MOON)The backyard of the Heafield's house (pronounced hayfield) Michigan's Upper Peninsula

FATHER
(calling) Margaret. Margaret. Time to come in. Margaret, where are you?

MARGARET CHILD
I'm out here Dad. In the garden.

FATHER
What are you doing? (coming to join her)

MARGARET
Nothing, Dad, just looking at the moon, at the stars. It's so clear tonight. it's almost like you could reach up and touch them.

FATHER
It's a beautiful night. But it's bedtime. Time to come in.

MARGARET HAMILTON
I am. In a minute. Dad, is that the North Star? That really bright one?

FATHER
It is. Ok missy, bedtime

MARGARET
Help me find the Little Dipper.

FATHER
All right. Now spot the North Star again. Have you got it. Here's a hint. How does the north star connect to the Little Dipper?

MARGARET
Oh, yeah. Now I remember. The North Star is at the end of its handle. Oh, and there's the Big Dipper. Can you see it (pointing it out). The end of it is pointing up to the North Star.

FATHER
Ok, sweetie, bedtime.
MARGARET
Dad, just one more question. When you were little did you ever think about flying?

FATHER
That was a long time ago.

MARGARET
(persisting) But did you want to?

FATHER
Bedtime...

MARGARET
Dad, sometimes I think I can fly. Not in an airplane. But really. Maybe to the moon.

FATHER
That’s pretty far.

MARGARET
How far?

FATHER
Oh, about 240,000 miles.

MARGARET
Yup. That’s pretty far.

FATHER
But you know, Bunny, you’re not alone.

MARGARET
Dad!!

FATHER (Continued)
What? Oh, sorry. Margaret. People have always dreamed about flying.

MARGARET
Really?

FATHER
For as long as we know, thousands of years, people have been telling stories about flying up into the sky, up into the heavens.

MARGARET
Tell me one.

FATHER
All right. *One.* About 2500 years ago, the Greeks told a story about a man named Daedalus and his son Icarus. They were being held prisoners in a tower. To escape the dad built 2 enormous pairs of wings with feathers he collected from the window sill of the
tower.

MARGARET
Did the wings work?

FATHER
They did. Daedalus and his son flew out of the window of the tower and escaped. But the story had a sad ending. Icarus was so excited to fly, he forgot his father’s warning and flew too close to the sun.

MARGARET
What happened?

FATHER
The feathers were held to the frame of the wings by wax. The sun melted the wax, the feathers came off and Icarus fell into the ocean. Now enough stories. bedtime.

MARGARET
Well, when I fly to the moon, I’m not making any mistakes.

FATHER
All right, Bunny. I mean Margaret. Now to bed

Handout #4 *Closing the STEM Gap: Why STEM classes and careers still lack girls* (Excerpted from the report commissioned by Microsoft, 2018)

Background

Despite the high priority placed on science, technology, engineering and math (STEM) and computer science education across the United States, the fact remains that only a fraction of girls and women are likely to pursue STEM degrees and careers. The U.S. Bureau of Labor Statistics predicts that technology professionals will experience the highest-growth in job numbers between now and 2030. Failing to bring the minds and perspectives of half the population to STEM and computer science fields stifles innovation and makes it less likely that we can solve today's social challenges at scale. Microsoft commissioned this research to understand better what causes girls and women to lose interest in STEM subjects and careers, as well as what strategies and interventions have the greatest potential to reverse this trend.

Insights

· Girls and young women have a hard time picturing themselves in STEM roles. They need more exposure to STEM jobs, female role models, and career awareness and planning.
· Girls don't initially see the potential for careers in STEM to be creative or have a positive impact on the world, but even a little exposure to real-world applications of STEM knowledge dramatically changes their outlook.
· Girls who participate in STEM clubs and activities outside of school are more likely to say they will pursue STEM subjects later in their education. The kinds of experiments and experiences girls are exposed to in these activities can provide insights for how to enhance STEM instruction in the classroom.
· Encouragement from teachers and parents makes a big difference in girls' interest in STEM—especially when it comes from both teachers and parents.
· Educators can foster a "growth mindset" among their female students by tapping into their willingness to work hard for results.

Strategies

· Provide more exposure to positive role models and mentors they can both relate to and aspire to be.
· Demonstrate a path forward in terms of turning an interest in STEM and computer science into success in school and in a career.
· Support extracurricular STEM activities that teach girls how to create and build confidence.
· Provide hands-on experiences and real-world examples.
· Emphasize the creative aspects of STEM and computer science.
· Demonstrate the dramatic impact that STEM and computer science jobs have on the world.
· Encourage parents, teachers and others influential in a girl's life to support and foster interest in STEM and computer science.
· Support teachers to develop strategies to engage students who are afraid to ask questions, be wrong or ask for additional help.
· Listen to what girls say about their challenges and desires.