AMAZON ORIGINAL

THE AERONAUTS

5E Instructional Planning Model

WOMEN AS AERONAUTS

GRADE LEVEL: 9–12

Topic/Theme/Nature of the Investigation

Examining the central role women played in the history of aeronautics, the many barriers they faced, and the scientific advances they made despite the obstacles.

Learning Targets Students can:	♦ Make connections to scientific fields related to aeronautics; ♦ Conduct independent historical research to build content knowledge and context; ♦ Communicate the barriers that women scientists faced in the 19th century; and ♦ Communicate the trailblazing efforts that women in aeronautics accomplished.
Common Core State Standards Connections: ELA/Literacy	**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments or technical processes. (HS-LS1-1),(HS-LS1-6) **WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6) **WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS LS1-3) **WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3) **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection and research. (HS-LS-1-1),(HS-LS1-6) **SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)
NGSS Performance Expectation(s) Next Generation Science Standards	HS-ETS1 Engineering Design
Duration	Two 50-minute periods

ENGAGE

Purpose

- To introduce the context of the lesson and Driving Questions;
- To engage students in exploring their thinking about the lesson topic;
- To reveal students' background knowledge to the teacher; and
- To engage students' interest.

The purpose of this lesson is for students to build background knowledge on women aeronauts to inform their viewing of the film *The Aeronauts* and to have a deeper and more accurate context for the Hot Air Balloon Engineering Challenge.

Students will explore the lives of several trailblazing women who formed the composite character of Amelia Wren from the film and critically examine the contributions of women in the fields of science during this era.

Driving Questions:	♦ What is aeronautics? ♦ What scientific fields contribute to aeronautics? ♦ How did the contribution of women aeronauts inform scientific discoveries? ♦ How does the film *The Aeronauts* inform student understanding?
Resources and Materials:	♦ Poster of Sophie Blanchard (published in 1811, Portrait of French balloonist Sophie Blanchard standing in the decorated basket of her balloon during her flight in Milan, Italy, in 1811, in the presence of the imperial and royal highness.) ♦ Poster of Sophie Blanchard (1819, rendition of the accident that led to her death) ♦ Poster of Margaret Graham (1850) ♦ Poster of Margaret Graham's balloon on fire (Mrs Graham's Balloon on fire, *Illustrated London News*, Aug. 17, 1850, p.137).
Procedures:	What is the teacher doing? What are the students doing? 1. Teacher introduces the topic by asking this open-ended question for students to respond to: **What is aeronautics?** (Definition) The term "aeronautics" originated in France, and was derived from the Greek words for "air" and "to sail." It is the study of flight and the operation of aircraft. **Aeronautics** is the study of the science, design, and manufacture of flying vehicles. This includes vehicles that fly in the air and spacecraft that pass through the air to reach space. 2. Teacher transitions to projecting several historical posters and asking students to closely examine the visual image as if they were analyzing an experiment. Teacher will lead students in an analysis of the posters using these questions: ♦ What do they see? ♦ What is happening in the poster, or what story does it tell? ♦ What "data" is available? ♦ What may be driving these scientists based on what the students see in the poster? Is there anything unusual about these posters?

EXPLORATION

Purpose

- To develop knowledge using research, explorations and investigations;
- To expand student knowledge on the scientific contribution of women in aeronautics; and
- To provide students with an accurate historical context of the risks and accomplishments of women in aeronautics.

Driving Questions:	♦ What is aeronautics and who is an aeronaut? ♦ What scientific fields contribute to aeronautics? ♦ How did the contribution of women aeronauts inform scientific discoveries? ♦ How does the film *The Aeronauts* inform student understanding?
Resources and Materials:	♦ Smithsonian Libraries: **Age of the Aeronaut** ♦ Smithsonian Air and Space Museum: **Capturing the Early History of Aeronautics** ♦ Atlas Obscura: **The Women Who Rose High in the Early Days of Hot Air Ballooning** ♦ Smithsonian Libraries: **Sophie Blanchard, Pioneering Aeronaut**
Procedures:	3. Brainstorm with students the range of fields they think are related to aeronautics (can include: engineering, aviation, aerodynamics, rocketry, aeronautical science, meteorology, navigation construction). 4. Transition to showing two clips from *The Aeronauts* as a way for students to understand the cultural and historical context of ballooning at the time. Watch Clip 1: Begins at 0:45 at the start of the film and ends at 06:42. Debrief with students: ♦ What observations can they make about the character of Amelia Wren from the very beginning? ♦ What questions do they have? 5. Transition to Clip 2: 01:21:40 – 01:26:50 Debrief with students: ♦ What is different about Amelia Wren in this segment compared with her portrayal at the opening of the film? ♦ What about James Glaisher? Explain to students that the character of Amelia Wren in the film is inspired by two women—Sophie Blanchard and Margaret Graham—who were featured in the posters they reviewed and who were prominent aeronauts in the 19th century. For the next part of the lessons, you will discover more about these trailblazing women aeronauts and scientists. 6. Organize students in groups of three. Each student will be assigned one of the three topics of research using the resources cited to begin. ♦ Explain the popularity of aeronauts; ♦ The role of women aeronauts (Sophie Blanchard and Margaret Graham as examples); and ♦ The scientific discoveries and contributions of aeronauts. 7. Explain to students that each group member will be responsible for creating one PowerPoint slide on their topic of research to inform their final poster project.

EXPLAIN–STUDENT COMMUNICATION PROJECT

Purpose
♦ To answer the Driving Questions through student research; ♦ To provide students with relevant vocabulary and historical context; and ♦ To deepen their content knowledge of aeronauts and demonstrate their learning by creating a PowerPoint presentation on three assigned topics. 8. Students will present their individual slide to their small group and teach their peers about their assigned topic.

Content Media (written material, video, technology):	Each small group will complete a deck of three PowerPoint slides to turn in along with their final assignment.

ELABORATE

Purpose
To extend students' research, synthesize their learning, and apply it to a new format.

Activities	9. At this point, student groups have completed their research and discussed their individual slides. The teacher will now explain that as a final assignment, each group will create an 8 x 10 historical poster, similar to the posters viewed at the beginning of the lesson, on one of the three assigned topics of research (explaining the popularity of aeronauts, the role of women aeronauts (Sophie Blanchard and Margaret Graham as examples), or the scientific discoveries and contributions of aeronauts in general. The group must work together to decide on the topic, the content and the design. Each poster must include these details: 1. Title or headline for the poster and an accompanying "artist" statement explaining the story behind the poster; 2. Compelling visual that communicates the core topic of the poster; 3. Three relevant historical details on the topic; and 4. Full list of citations used in students' research.

EVALUATE

Purpose
♦ To assess and evaluate student learning and understanding of the historical context of the science of aeronautics; and ♦ To foster critical media literacy by having students present their media-based research with peer groups.

Skill/Reasoning Learning Objectives	Obtaining, evaluating and communicating information ♦ Compare, integrate and evaluate sources of information presented in different media or formats as well as in words in order to address a scientific question or solve a problem.
Assessment Instrument	Historical Poster on Aeronaut Research

NAME: _____

RUBRIC: WOMEN AERONAUTS

HISTORICAL POSTER

	4 points	3 points	2 points	1 point
Understanding the contribution of women aeronauts beginning in the 19th century.	In the artist statement and poster, groups share an in-depth understanding of the role of women aeronauts and are able to visually communicate their ideas, with several compelling examples.	In the artist statement, groups share a general understanding of the role of women aeronauts and are able to visually communicate their ideas in at least one example.	In the artist statement, groups share a basic understanding of women aeronauts and their contributions during the time period and are able to visually communicate their ideas with very basic representations.	In the artist statement, groups share very little or no understanding of women in aeronautics and their contributions during the time period. Their visual representations also show no understanding.
Understanding the barriers that women aeronauts faced.	Group's poster communicates specific political, economic or cultural barriers women aeronauts faced, and visually offers several examples of the obstacles, and an analysis of how women were able to overcome these obstacles in the artist's statement.	Group's poster communicates a general understanding of the historical barriers women aeronauts faced and cites at least one example of how women were able to overcome these obstacles.	Group's poster communicates a superficial understanding of the historical barriers women aeronauts faced and how they were able to overcome these obstacles.	Groups communicate very little understanding of the historical barriers women aeronauts faced and are not able to identify how women aeronauts were able to overcome these obstacles.

AMAZON ORIGINAL

THE AERONAUTS

5E Instructional Planning Model

INSPIRING WOMEN IN STEM:

Applying the Story of *The Aeronauts* for Science Discovery

GRADE LEVEL: 9–12

Topic/Theme/Nature of the Investigation
Celebrating the advances of women in STEM-related fields and critically examining ongoing inequities in the field

NGSS Performance Expectation(s) Next Generation Science Standards	HS-ETS1 Engineering Design
Duration	Two 50-minute periods

ENGAGE

Purpose

- To introduce the lesson and the Driving Questions;
- To engage students in exploring their thinking about the lesson topic of women in STEM-related fields; and
- To reveal students' points of view on issues of equity in science, technology, engineering and math (STEM).

The purpose of this lesson is to engage students in an analysis of contemporary equity issues as they relate to women in science and STEM-related fields Using a film clip from *The Aeronauts* as a narrative inspiration and point of departure, students will examine the following questions:

Driving Questions:	♦ Who are trailblazing women in STEM? ♦ What factors contribute to gender inequities in STEM-related fields? ♦ What are the policies and practices that can be incorporated to address these inequities?
Resources and Materials:	♦ "Women in Science Profiles" https://www.pbs.org/show/women-science-profiles/episodes/ ♦ November 2019 *National Geographic* Women: A Century of Change Copy, buy or write to *National Geographic* and ask them to send your class this issue and copy these two articles: 1. "Once, Most Famous Scientists Were Men, But That's Changing," by Angela Saini 2. "For Girls in Science, the Time is Now," by Claudia Kalb ** *This is a wonderful exploration of women in science but it is subscription based. Check with your local library to see if they have a copy available.* ♦ "What Science Has Gotten Wrong by Ignoring Women." *National Geographic*, December 2018 ♦ "Women and Men in STEM Often at Odds Over Workplace Equity" Appendix: Detailed tables and charts
Procedures:	What is the teacher doing? What are the students doing? The teacher begins the lesson with connecting to *The Aeronauts* and asking students to critically analyze the clip chosen for who and what is missing, particularly as it relates to women in science. Set the context that the characters in the balloon are descending too quickly and need to figure out how to land. The scene starts when James Glaisher decides to cut the basket first and then the ropes around the bottom of the balloon, so the balloon, in essence, becomes a parachute. **Go to 01:30:35 – 01:36:16** Debrief what the students noticed from *The Aeronauts* clip. Details may include the lack of women at the Royal Society of London, Glaisher's recognition of Amelia Wren in his speech, and her continued work with him at the end of the movie. (You may note that the scenes are influenced by Hollywood, but inspired by actual women.) Ask students to raise their hands if they agree with the following statements: ♦ Over the past decade, women have surpassed men in STEM-related professions. ♦ Over the past decade, women have declined in STEM-related professions. ♦ Over the past decade, women and men are equally represented in STEM-related professions. * ♦ Education is the most important solution to equalize women and men in STEM-related fields. ♦ Policy and cultural shifts are the most important solutions to equalize women and men in STEM-related fields.

* A recent U.N. report says that in 2019, less than 30 percent of the world's science researchers are women: https://www.nationalgeographic.com/science/2019/10/women-stem-gaining-recognition-feature/.

EXPLORE: WHAT IS THE CURRENT STATE OF AFFAIRS OF WOMEN IN STEM?

Purpose

- To reflect on the questions posed by the teacher about the current state of inequity with women in science;
- To critically examine the current field of STEM education and professional opportunities in regard to gender equity; and
- To evaluate the opportunities and the barriers that remain for women in STEM-related fields by analyzing data sets.

Driving Questions:	♦ Who are trailblazing women in STEM? ♦ Why is STEM a field where women are in the minority?
Activities:	1. Teacher will explain to students that their work over the course of this class will be to investigate the current status of women in STEM fields in order to be informed on the current state of affairs and to work toward greater parity and to enhance the overall field. 2. If possible, distribute the article from the November 2019 *National Geographic* edition **"Once, Most Famous Scientists Were Men, But That's Changing,"** by Angela Saini. 3. Have students do a close read of the articles taking notes on critical information they can use later in a Philosophical Chairs discussion about the current status of women in STEM.

STUDENT COMMUNICATION PROJECT

EXPLAIN: THE COUNTERPOINT TO THE INEQUITIES ARE THE INSPIRATIONAL LEADERS

Purpose

- To have students assess the current status of women in STEM through sharing evidence and/or stories that support their claims;
- To have students answer the Driving Questions for the lesson; and
- To provide students with relevant vocabulary, statistics and role models to inspire their pursuit of science.

Content Media (written material, video, technology):	4. Recommended sources for students to explore: Their objective is to identify the key factors that continue to support the success of women in STEM today, and what still needs to be addressed for more women to enter the field. Students can view the five "Women in Science Profiles" video pieces **here**. November 2019 *National Geographic* **Women: A Century of Change** and the article **"For Girls in Science, the Time is Now,"** by Claudia Kalb. **"What Science Has Gotten Wrong by Ignoring Women."** *National Geographic*, December 2018.

ELABORATE

Purpose

- To juxtapose the success of women in STEM-related fields with data on the disparities and inequities that exist today; and
- To examine the Driving Question: What are factors that continue to contribute to gender inequities in STEM-related fields?

Activities

5. Explain to students that the Pew Research Center compiled an extensive set of data and infographics within a study titled **"Women and Men in STEM Often at Odds in Workplace Equity."** Within the Pew study is a large data set of 95 different tables and charts available for students to explore: **Appendix: Detailed tables and charts**
6. It is important for students to review a selection of data and synthesize their analysis into a coherent argument on the state of women in the STEM field.

EVALUATE

Purpose

To have students share their stance on the current state of women in STEM-related fields through a **Philosophical Chairs discussion**.

Activities

7. If this is the first Philosophical Chairs discussion, go over the general parameters of the exercise and present the statement below. If students are seasoned in the exercise, ask for a student volunteer to present the statement and facilitate the process moving forward.
    - The teacher or a student presents a statement for the class to consider such as:

"To even the playing field, STEM education should invest more heavily in girls than in boys. Once women hold an equal number of research positions, academic roles, etc., the priority on girls can return to a more equitable distribution of attention and resources."

- All students spend three minutes writing their ideas about the statement;
- They decide which position they'll take on the statement (yes, no, undecided);
- They discuss their ideas and positions for about 10 to 15 minutes; and
- They write a reflection that includes the comment that most challenged their thinking; whether they changed their mind or not; and how open-minded they were at the start of the conversation. (Excerpted from Edutopia: A Framework for Whole Class Discussions.)

8. Before sharing the reflective writing statement, read aloud the excerpt from **Girls and the Next Generation Science Standards** (NGSS) in the handout as one point of view to consider. It may be helpful to make copies of the article for students to follow along, underlining important information and data points they can reference during the exercise.

Skill/Reasoning Learning Objectives

Obtaining, evaluating and communicating information

- Compare, integrate and evaluate sources of information presented in different media or formats as well as in words in order to address a scientific question or solve a problem.
- Philosophical Chairs Discussion

HANDOUT: BACKGROUND READING

PHILOSOPHICAL CHAIRS DISCUSSION

Girls and the Next Generation Science Standards (NGSS)

The NGSS pave the way for increased exposure to all disciplines of science for all students. This is a breakthrough, in particular, for girls, as research attributes gender disparities in science achievement, college degrees, and careers to an early "experience gap" between girls and boys. The NGSS provide an opportunity for teachers to reach girls more effectively because girls perceive a disconnect between school science learning and science career goals (Baker, 2013.) Research points to three main areas where schools can positively impact girls' achievement, confidence and affinity with science: (1) instructional strategies, (2) curricula and (3) classroom and school structure (Baker, 2013; Scantlebury & Baker, 2007) .

First, teachers can use instructional strategies to increase girls' science achievement and to strengthen their intention to continue on in science. Such strategies include building opportunities to experience phenomena and framing science as inquiry. Girls respond well to strategies that integrate literacy with science. When teachers explicitly focus on metacognitive comprehension strategies, by using nonfiction texts in science class, girls' science learning and achievement are enhanced. Girls would gain confidence in classrooms where risk taking is encouraged, teachers would support positive messages about girls' competence, and it would clearly be conveyed that "science is for all."

Second, curricula can improve girls' achievement and confidence in science by promoting images of successful females in science. Schools can enhance girls' engagement in science by adopting curricula that focus on science topics related to the girls' interests. Similarly, girls develop aptitude and confidence toward nontraditional science topics when they are exposed to the topics early. For example, when girls have early exposure, they are more interested in computers and technology. Girls become more motivated toward technology if the curriculum incorporates design and stresses aesthetic aspects of science. In addition, girls respond to topics in physical and biological sciences that they perceive as addressing issues relevant to the real world.

Finally, research supports adjusting classrooms' and schools' organizational structures in ways that benefit girls. For example, after-school clubs, summer camps and mentoring programs enhance girls' confidence toward science and increase mastery of science content. Girls benefit from science and engineering activities that are intentionally designed to give active roles to all learners. This may occur through thoughtfully planned instructional grouping, pairing girls with friends, and giving every student her own materials to tinker with. Although placing girls in all- girl schools is not known to improve their science achievement, it is sometimes possible to improve results through all-girl groupings within classes containing boys and girls.

https://www.nextgenscience.org/sites/default/files/%285%29%20Case%20Study%20Girls%206-14-13.pdf