



Prioritize Your Flight

NASA Office of STEM Engagement Next Gen STEM

EDUCATOR NOTES

Learning Objectives

Students will:

- Analyze and determine features of an aircraft that will create the fewest environmental impacts while maintaining comfort for passengers
- Defend their choices with valid arguments

Investigation Overview

In this activity, students will learn about NASA's research in aviation and the work NASA is doing to create a sustainable future in flight for us all. While working in groups, students will analyze a list of considerations for the ideal flight, from wing design to the number of seats on board, rank their preferences from most important to least important, and defend their choices to the other student groups.

Safety

- Practice safe cutting techniques when using scissors. Students should carefully support the piece they are cutting while safely moving and placing their free hand.
- Avoid moving around the room with scissors or other sharp objects

Investigation Preparation

- Distribute one copy of the Student Handout (found below) to each group
- Read through the handout and how to introduce this investigation
- Watch [NASA's Earth Minute: The Usual Suspects](#), or share the book [The Air We Breathe](#)

Introduce the Challenge

Aviation is a constantly changing industry which impacts all segments of our society. It is necessary for moving people and materials quickly between locations. The industry has long been an essential part of our global economy and provides millions of jobs.

As fossil fuel prices vary, so does the cost of cargo delivery between local and international destinations. Companies pass these expenses on to their customers, increasing the price people pay for goods. Increasing fuel prices may also impact tourism and a family's decision to take a family vacation.

In response to the changing cost of oil, airliners have developed creative methods to save money on fuel costs by reducing the weight of their daily flights. A lighter aircraft consumes less fuel and minimizes carbon emissions. Even though many of these changes seem small, they can make a huge impact.

ELEMENTARY

Grades 3-5

Suggested Pacing

45 minutes

Materials

- Student Handout (1 per group)
- Writing utensil
- Scissors

National STEM Standards

- [3-5-ETS1-1 Engineering Design](#)
- [3-5ETS1-2 Engineering Design](#)
- [5-ESS3-1 Earth and Human Activity](#)



The Future of Flight

Facilitate the Investigation

MEET THE PROBLEM

- When shopping, people have many choices in the products they buy. People choose products for different reasons. Choices are based on price, quality, available features, brand preference, and many other factors.
- Who makes these choices when planning the ideal flight on an aircraft?

EXPLORE KNOWN AND UNKNOWN

Passenger Decisions: Round 1

1. Distribute pictures of different aircraft features to the student groups
2. Have the students cut apart the aircraft feature pictures and lay them face up on the table
3. Have the students choose, as a group, the top eight features they would use in planning their ideal flight if they were going to be passengers
4. Have the students place the pictures on the Design Chart from most important to least important, where 1=most important and 8=least important and record their initial answers on the handout

GENERATE POSSIBLE SOLUTIONS

Engineer Decisions: Round 2

- NASA is working towards reducing energy and emissions. For this round, when the groups place their aircraft feature cards in order of importance, they will pretend to be NASA engineers.
- From an engineer's point of view, there are some specific features to consider: materials, cost, customer comfort, etc. Have the groups discuss the features they might consider when planning the ideal flight as an engineer.
- Have the students place the pictures on the Design Chart from most important to least important, where 1=most important and 8=least important






CONSIDER CONSEQUENCES

- When the groups have made their final decisions, have the students list, on the Ranking Chart, their top eight features and why those particular options are important. Be sure to have them reference the Pros-Cons sheet to defend their reasoning.
- Have the students discuss these questions as a group, and have the groups record their answers on the Student Handout
 - Considering all the cards, which features would need to be sacrificed to improve fuel efficiency? Why?
 - What items would need to be sacrificed to improve passenger experience? Why?
 - Compare your list from round 1 to your list from round 2. Think about the differences between your lists and provide possible reasons for the differences.
- Real World Connection: Consider including a discussion on how these decisions affect real-world aviation and the environment

PRESENT FINDINGS

- Have the student groups summarize their experience of prioritizing the ideal flight from the perspectives of a passenger and a NASA engineer. Encourage the groups to include details such as:
 - In what ways did your focus change when you switched from pretending to be a passenger to acting like a NASA engineer?
 - Which role required more thinking?
 - How do you think the different perspectives work together to create flights as we know them today?

Rubric for Problem-Based Learning (PBL)

PBL Step	Novice (0)	Apprentice (1)	Journey person (2)	Expert (3)	Level of student knowledge (Score)
MEET THE PROBLEM 	Student does not identify the problem	Student incorrectly identifies the problem	Student identifies part of the problem	Student fully and correctly identifies the problem	
EXPLORE KNOWN & UNKNOWN 	Student does not identify knowns and unknowns	Student incompletely identifies knowns and unknowns	Student identifies knowns and unknowns using experience but uses no resources	Student completely identifies knowns and unknowns using experience and resources	
GENERATE POSSIBLE SOLUTIONS 	Student does not brainstorm	Student generates one possible solution	Student provides two possible solutions	Student provides three or more possible solutions	
CONSIDER CONSEQUENCES 	Student does not identify any consequences	Student determines inaccurate or irrelevant consequences	Student identifies consequences accurately	Student identifies consequences accurately and provides a rationale	
PRESENT FINDINGS 	Student does not communicate results	Student shares random results	Student shares organized results, but results are incomplete	Student shares detailed, organized results with class	
Total					

Reference

NASA Aeronautics Dream with Us Design Challenge www.nasa.gov/aeronautics/nasa-aeronautics-dream-with-us-design-challenge/

Extensions

- Have students create aircraft feature cards based on their own research and ideas on necessary aircraft components
- Have groups exchange the new aircraft feature cards and complete the activity, outlined in the bullets below, using the new feature cards
 - Break students into teams
 - Assign each team a different flight perspective (one team focused on engineering, one team focused on customer experience, one team focused on environmental impacts, and one team focused on marketing) and use the pictures and design chart to create a new priority list from their new perspective
 - Have each group pick different aircraft feature items according to their assigned perspective and discuss as a larger group why the flight priorities are different for each team perspective
 - Consider allowing students to design a prototype of their ideal aircraft
 - Have students research aeronautics careers
- For more information on renewable/nonrenewable energy resources, check out the article on a renewable energy scientist here: <https://climatekids.nasa.gov/career-wind-energy/>

Additional Resources

Next Gen STEM for Educators www.nasa.gov/learning-resources/for-educators/

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STUDENT HANDOUT

Your Investigation

In this activity, you will learn about NASA's research in aviation and the work NASA is doing to create a sustainable future in flight for us all. You will be looking at a list of considerations for conducting an ideal flight, from wing design to the number of seats on board and ranking your preferences from most important to least important.

? MEET THE PROBLEM

- When shopping, people have many choices in the products they buy, and they choose different products for different reasons. They make choices based on price, quality, available features, brand preference, and many other factors.
- Who makes these choices when planning the ideal flight on an aircraft?

EXPLORE KNOWNs AND UNKNOWNs

1. Cut apart the pictures and lay them face up on the table
2. As a group, choose the top eight features you would use to plan your ideal **passenger** flight
3. Place the pictures on the Design Chart from most important to least important, where 1=most important and 8=least important

List your choices here:

- | | |
|----|----|
| 1. | 5. |
| 2. | 6. |
| 3. | 7. |
| 4. | 8. |

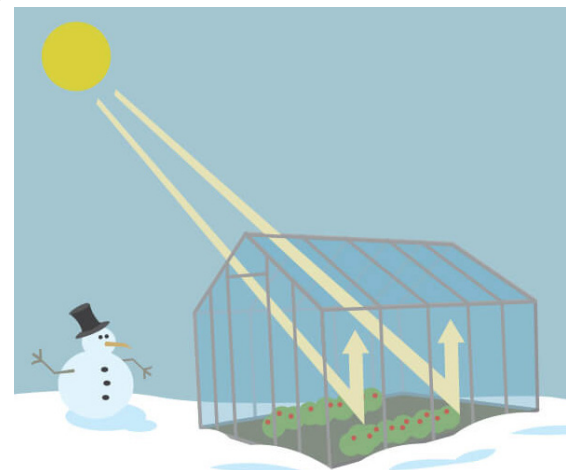
GENERATE POSSIBLE SOLUTIONs

- NASA is working towards reducing energy and emissions. For this round, pretend to be **NASA engineers** and place the cards in order from 1 to 8.
- Consider the following when choosing your design: the materials, cost, customer comfort, and other features that affect people and the aviation industry
- Place the pictures on the Design Chart from most important to least important, where 1=most important and 8=least important
- List your choices here:

- | | |
|----|----|
| 1. | 5. |
| 2. | 6. |
| 3. | 7. |
| 4. | 8. |

ELEMENTARY

Grades 3-5



FUN FACT!

Greenhouse gases are gases that can trap heat. They get their name from greenhouses. A greenhouse is full of windows that let in sunlight. That sunlight creates warmth. The big trick of the greenhouse is that it doesn't let that warmth escape.



Collect the greenhouse gas trading cards at climatekids.nasa.gov/greenhouse-cards/

Design Chart

GRADES 3-5

1	2
3	4
5	6
7	8

Ranking Chart

GRADES 3-5

Item	Why is this item important?
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

Airplane Features

GRADES 3-5



Screen in Seatback



Snacks



Lighter Aircraft Structure



Fuel Efficiency



Charging Station



Aisle Lighting



Alternative Fuel



Cost per Carry-on Bag



In-Flight Meals



Drink Cart



Air Vent



Reading Light



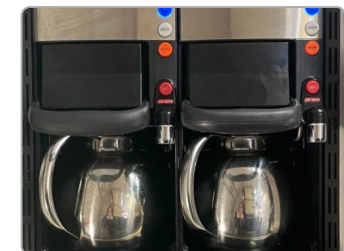
Hot Water Systems



Cost of Ticket



Bathroom



Coffee/Tea Maker

Prioritize Your Flight: PROS and CONS of Airplane Features



Reading Lighting

- Pros: Provides a light for each person without bothering others
- Cons: Each light adds weight to the aircraft, and using individual lights uses more energy



Fuel Efficiency

- Pros: Decreases the amount of fuel used
- Cons: With less fuel being used, the flights are slower, and aircraft can't carry as much weight, so there are fewer passenger comforts, and less baggage on the aircraft



Hot Water Systems

- Pros: Provides comfortable temperature for washing hands in restrooms
- Cons: Requires a holding tank and extra power which adds weight to the aircraft



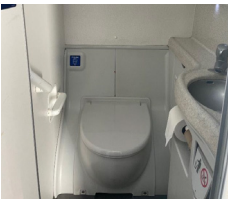
Drink Cart

- Pros: Provides comfort for passengers during the flight
- Cons: The drinks, cups, ice, and service carts add weight to the aircraft, and single-use cups add to the amount of trash



Lighter Aircraft Structure

- Pros: New designs and materials can produce lighter aircrafts which can decrease the use of fuel
- Cons: Designing and building new aircraft is expensive



Bathrooms

- Pros: Provide relief to passengers and is necessary for good health.
- Cons: The bathroom plumbing adds weight to the aircraft, takes up room in the cabin, and adds to the cost of maintaining the aircraft



Aisle Lighting

- Pros: Helps people see when walking around the cabin, and helps people find the exit during an emergency
- Cons: Each light adds weight to the aircraft, uses energy, and increases the price to keep the aircraft in good condition



Coffee/Tea Maker

- Pros: Provides comfort for the passengers
- Cons: Makes flights more expensive because items need to be restocked before each flight, takes more energy, and creates more trash



Alternative Fuel

- Pros: Produces fewer emissions, or harmful gases, more reliable than fossil fuels, like gasoline, and reduces the time and cost to repair the aircraft
- Cons: Electric energy, by itself, may not give larger aircrafts the force they need to takeoff, and electric batteries are heavy



Screens in Seatbacks

- Pros: Provide flight information and entertainment like tv shows and movies
- Cons: The screens and needed equipment add weight and use more power



Cost Per Carry-on Bag

- Pros: Increases the comfort for passengers by allowing them to store their bags in overhead bins and saves time
- Cons: The cabin space required to store luggage reduces the space inside of the aircraft, making it more uncomfortable for passengers, and added luggage weight adds to the cost of fuel



Personal Overhead Fan

- Pros: Provide comfort for passengers
- Cons: Vents for each fan adds to the overall weight and cost to maintain the aircraft



Cost of Ticket

- Pros: Lower ticket costs make air travel possible for more people
- Cons: Because it is cheaper to fly the airline may decrease the number of comfort items on the aircraft, spend less money designing future aircraft, and charge customers baggage fees to prevent losing money



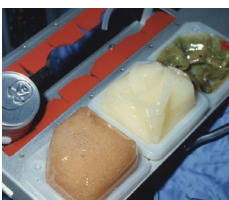
Snacks

- Pros: Provide comfort and food to passengers during flights
- Cons: Individually packaged snacks add to the trash and increased time and money are spent restocking the aircraft with snacks between flights



Charging Outlets

- Pros: Allows people to charge their personal cell phones and tablets
- Cons: The equipment adds to the weight and the amount of power needed









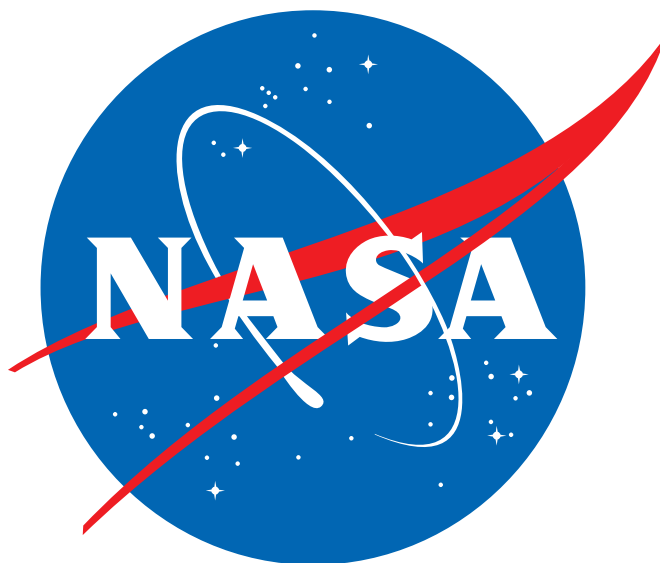
Meal Options

- Pros: Provides comfort for passengers and helps with the need for a meal on longer flights
- Cons: Different meal choices and cooking equipment are expensive, it adds weight, and takes up additional space inside the aircraft

Culturally Responsive Education (CRE) Strategies Tip Sheet:

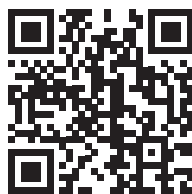
There are six CRE strategies for student engagement. The table below shows the cultural capital approach and corresponding icon as well as how strategies are integrated throughout the guide. Each example corresponds to at least one of six major strategies as noted below and recommended for best practices in CRE. Full descriptions of these strategies are given in the STEM Curriculum Review Framework (SCRF); adopted from Martinez Ortiz et al., 2019 as cited and highlighted in Sangam & Martinez Ortiz, 2020).

Section Title (page #)	CRE Strategy	CRE Tips
Student Handouts pg. 4-10	 Making Cultural Connections	<ul style="list-style-type: none"> Use multimedia resources such as videos, graphics, slideshows, diagrams, etc
Generate Possible Solutions Consider Consequences pg. 2	 Language and Communications	<ul style="list-style-type: none"> This activity provides the opportunity for students to share information in groups
Explore Knowns and Unknowns and Generate Possible Solutions pg. 2 Rubric pg. 3	 High Expectations	<ul style="list-style-type: none"> Cooperative learning that promotes problem-solving Rubrics for grading Real-Life and Current Connections
Present Findings Pg. 2 Extensions pg. 3	 Student Identity and Funds of Knowledge	<ul style="list-style-type: none"> Student reflection – can be used a summarizing, closing strategy to provide opportunities to reflect on their learning experiences Use extended reflections for students to design their own scenario or experiment
Present Findings Pg. 2	 Critical Knowledge and Social Justice	<ul style="list-style-type: none"> When posing questions to the group for discussion, allow students to think and reflect silently or use written words, then pair them up with someone to exchange ideas. Allow for a whole group discussion integrating different team ideas as time permits, choosing diversity in selections for sharing in the whole group.
Extensions Pg. 3	 Power and Participatio	<ul style="list-style-type: none"> Utilize team roles in experiments to encourage all students participate and/or experience leadership roles. Examples of roles: chief scientist, project manager, materials manager, evaluation plan officer, data recorder, graphics/illustrator.



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<https://stemgateway.nasa.gov/connects/s>



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