



Controlling the Plane

LESSON DESCRIPTION

The students will construct a working model straw glider, identify the major parts of an airplane, and experimentally determine how the ailerons, elevators, and rudders control a glider.

OBJECTIVES

The students will

- Explain how the ailerons, rudder, and elevator control the direction of the airplane
- Identify the movements of roll, pitch, and yaw
- Construct an airplane, test it, and graph the results of their test flights

NASA SUMMER OF INNOVATION UNIT

Physical Science—Aeronautics

GRADE LEVELS

4 – 6

CONNECTION TO CURRICULUM

Science, Mathematics, and Technology

TEACHER PREPARATION TIME

1 hour

LESSON TIME NEEDED

2 hours

Complexity: Moderate

NATIONAL STANDARDS

National Science Education Standards (NSTA) Science

Science as Inquiry

- Understanding of scientific concepts
- An appreciation of “how we know” what we know in science
- Understanding of the nature of science
- Skills necessary to become independent inquirers about the natural world
- The dispositions to use the skills, abilities, and attitudes associated with science

Physical Science Standards

- Motions and forces
- Transfer of energy

Science and Technology Standards

- Abilities of technological design
- Understanding about science and technology

History and Nature of Science Standards

- Science as a human endeavor

Common Core State Standards for Mathematics (NCTM)

Operations and Algebraic Thinking

- Use the four operations with whole numbers to solve problems
- Generate and analyze patterns

Operations and Algebraic Thinking

- Analyze patterns and relationships
- Write and interpret numerical expressions

Analyze patterns and relationships

ISTE NETS Performance Indicators for Students (ISTE)

Creativity and Innovation

- Create original works as a means of personal or group expression
- Use models and simulations to explore complex systems and issues

Communication and Collaboration

- Contribute to project teams to produce original works or solve problems

Research and Information Fluency

- Plan strategies to guide inquiry
- Process data and report results

Critical Thinking, Problem Solving, and Decision Making

- Identify and define authentic problems and significant questions for investigation
- Plan and manage activities to develop a solution or complete a project
- Collect and analyze data to identify solutions and/or make informed decisions

Technology Operations and Concepts

- Understand and use technology systems
- Select and use applications effectively and productively
- Troubleshoot systems and applications

MANAGEMENT

Materials and procedures are detailed in the activity. Each student will construct a plane, but having students work in teams of two or three allows them to help one another. If possible, allow students to choose different colors of paper (this helps with identifying their planes).

CONTENT RESEARCH

Gliders are one type of aircraft. (The four categories of aircraft are airplanes, gliders, rotorcraft, and hot air balloons.)

Key concepts:

- **Fuselage:** the long, narrow part of the aircraft going down the center that contains the main systems of the plane and space for the cockpit, passengers, and cargo and to which the wings and tail are attached
 - **Cockpit:** control center where the pilot, instrumentation, and navigational aids used in flying are located
 - **Engine:** part of the airplane that provides the power (thrust) for sustaining flight and for takeoff and landing
 - **Landing gear:** wheels, floats, or skis of an aircraft
- **Wings:** long areas of the plane extending from the fuselage that produce lift as the plane moves through the air
 - **Ailerons:** surfaces on the outer trailing edge of the wing that move up and down to roll the plane and bank the wings into a turn
 - **Flaps:** part of the trailing edge of the wing that is lowered to increase lift and also to slow the aircraft down for landing by increasing drag
- **Tail:** also called the empennage; the rear part of an aircraft, including the horizontal and vertical stabilizers, elevators, and rudder
 - **Vertical stabilizer:** the vertical winglike part of an aircraft's tail assembly that is fixed and to which the rudder is hinged
 - **Rudder:** a vertical part usually hinged to the vertical stabilizer and used to move the aircraft left or right (yaw)
 - **Horizontal stabilizer:** the horizontal wing-like part of an aircraft's tail assembly that is fixed and to which the elevator is hinged
 - **Elevator:** surface on the horizontal part of the tail section that moves up or down to control the up and down motion (pitch) of the plane

MATERIALS

- A copy of the instructions "Making a Straw Plane," for each group of students
- A 12-inch (30.5-centimeter), strong, plastic straw for each student
- A 12- by 18-inch (30.5- by 45.7-centimeter) sheet of heavy card stock or other stiff paper for each student
- Clear tape
- Paper clips
- Scissors
- A 12-inch (30.5-centimeter) ruler
- A copy of the Straw Plane Experiments 1–4
- Copies of the Straw Plane Experiments 1–4 for each student
- Calculator
- Overhead projector
- A graph transparency
- A free-flying area and a measured area for test flights

Misconception:

- All airplanes have engines to make them fly.
- Gliders do not have any engines. Gliders soar.
- Wings are curved to generate lift (Bernoulli Principle).

LESSON ACTIVITIES

- Straw Plane Experiment 1—Ailerons
Fly a straw glider keeping elevators and rudder neutral and change ailerons position.
Record direction of the glider.
- Straw Plane Experiment 2—Elevators
Fly a straw glider keeping ailerons and rudder neutral and change elevator position.
Record direction of the glider.
- Straw Plane Experiment 3—Rudders
Fly a straw glider keeping ailerons and elevators neutral and change rudder position.
Record direction of the glider.
- Straw Plane Experiment 4—Flight Tests
Adjust the ailerons, elevator, and rudder of the plane to any position that will make it fly the greatest distance—up, down, flat, or straight.
Record distance of the glider.
- Compute the range, mean, and median distances of the flights.
http://www.nasa.gov/pdf/265907main_The_Courage_to_Soar.pdf

ADDITIONAL RESOURCES

NASA Aeronautics Homepage:

Related sites:

- X-48 Blended Wing Body
- Aeronautics research videos in high definition
- NASA Dryden Research Aircraft Photo Gallery (X-planes from the 1940s to today)
- Current Aircraft Photos of aircraft flying at NASA Dryden Flight Research Center
<http://www.nasa.gov/topics/aeronautics/index.html>

NASA Paper airplane activities:

- Paper Templates for four different NASA airplanes: X-34A, F-16XL, Space Shuttle, and Centurion
- Future Flight Design Paper Airplane Poster
<http://futureflight.arc.nasa.gov/designs/index.html>

Aeronautics Research Poster:

- X-48B blended wing body test vehicle
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Aeronautics_Research_Poster.html

The Beginner's Guide to Aeronautics Homepage:

- Aircraft Motion – interactive simulators, animated movies
- Airplane Parts – interactive, fact sheets
- Aircraft Forces – interactive, animated movies
- Thrust – interactive simulator, fact sheets
- Weight – movies, fact sheets
- Lift – interactive, interactive simulator, animated movies
- Drag – interactive simulator, fact sheets
- Gliders – fact sheets, paper templates
- Wind Tunnels – interactive simulator, fact sheets

<http://www.grc.nasa.gov/WWW/K-12/airplane/index.html>

NASA Glenn Research Center. "Ultra-Efficient Engine Technology Kid's Page." *Airplanes*.

<http://www.ueet.nasa.gov/StudentSite/airplanes.html#partsofplane>

Cornish, Jim. "Science of Flight." *Parts of an Airplane, Controlling an Airplane*.
http://www.classbrain.com/artteach/uploads/scienceinflight_web.pdf

DISCUSSION QUESTIONS

- What are some of the most modern airplanes? *F–22 Raptor, the F–35 Joint Strike Fighter, the C–17 Globemaster III, the Boeing 777, the Airbus 380, the Cessna Citation CJ3, and the Gulfstream G550*
- Can you write a short paragraph and answer the following questions about your own super plane?
 - Is it military, commercial, or private? *Imaginary, answers will vary*
 - Purpose—How will it be used? *Imaginary, answers will vary*
 - Capacity—How many passengers or how much cargo can it carry? *Imaginary, answers will vary*
 - Range—How far can it fly before refueling? *Imaginary, answers will vary*
 - Speed? *Imaginary, answers will vary*
 - Special capabilities and equipment? *Imaginary, answers will vary*
 - A name for the plane? *Imaginary, answers will vary*
- What are the parts of an airplane? *Fuselage (contains cockpit, engine, and landing gear); wings (contains ailerons and flaps) and tail (contains vertical stabilizer, rudder, horizontal stabilizer, and rudder)*
- How do ailerons affect the direction an airplane flies? *Changes roll (rotates body)*
- How do elevators affect the direction an airplane flies? *Changes pitch (up and down)*
- How does the rudder affect the direction of the airplane? *Changes yaw (side-to-side)*
- In what positions do I put the ailerons, elevator, and rudder to make my plane fly the greatest distance? *Ailerons, elevator, and rudder in a neutral or flat position*

ASSESSMENT ACTIVITIES

Use Student Data Sheets to evaluate activities.

ENRICHMENT

Design a straw loop (round wing) airplane activity

<http://quest.arc.nasa.gov/aero/teachers/ia3.html>

Controlling the Flight Lesson 20: It's All About Control

- Design Your Own Super Plane
Research a modern plane and design a super plane. Make a poster and include a diagram of the super plane and label the important parts.
- Student reading text, "It's All About Control"
- Imaginary Planes Poster
- Parts of an Airplane diagram

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/The_Courage_to_Soar.html

Aeronautics Educator Guide

Right Flight activities:

- Construct styrofoam model gliders from Wright Flyer and Delta Wing templates
- Let's Build a Table Top Airport

<http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Aeronautics.html>

NASA Digital Learning Network

Event Catalog:

- Can a Shoebox Fly Challenge: Parts 1 and 2
- Flight in Earth's Skies

<http://www.nasa.gov/offices/education/programs/national/dln/index.html>