Teaching Guide
“The Science of Flight”

This digital learning pathway invites students to explore the physical principles that govern flight, from hot-air balloons to helicopters, through videos, illustrated explanations, and historical anecdotes.

It is organized into **four thematic chapters**, each framed by an introductory quiz and a final quiz to assess the students' progress in learning.

Each chapter links a **physical phenomenon** (convection, lift, gravity, rotation) to one or more **historical figures in aviation**.

The course can be used as an introductory activity, to conclude a unit on forces and motion, or as part of an interdisciplinary project (e.g. science, history, visual arts).

COURSE DETAILS

Learning Objectives:

- Identify the forces acting on a flying object
- Understand the role of air in flight
- Connect a physical phenomenon to its technological application
- Understand how a hot-air balloon, an aeroplane, and a helicopter work
- Learn major milestones in the history of aviation

Links to the school curriculum:

- Describe the interactions between objects and the forces acting on them; understand how technical objects work and grasp the concepts of weight, gravity, and lift in the context of the study of motion.
- Apply knowledge of the major transformations associated with industrialization and technical progress (19th–20th centuries) and study the individual and collective journeys of historical figures.
- Recognize women’s contributions to science and foster respect for gender equality in the professional world.
- Use digital resources responsibly and actively, and understand that digital content can convey validated scientific knowledge.

Usage: Group activity

Materials needed:
A computer with an internet connection
A video projector or interactive whiteboard

Workshop duration: 50 to 55 minutes

Teaching Methods:
Group activities, quizzes, videos, guided discussions

SESSION PROCEDURE

At the very beginning of the session, please provide the number of participating students for statistical purposes.

QUIZ

The module begins and ends with the same 7-question quiz.
This approach allows for an objective assessment of students' progress and serves as a basis for debriefing.

Group format: Students vote by a show of hands on each statement.
This encourages discussion and treats mistakes as a starting point for learning.

- Before the activity: Write the voting results on the board (the answer is validated by the majority of raised hands) without correcting them. Briefly ask students to explain their reasoning.

- After the activity: Repeat the quiz, compare the results, and work together to identify which concepts have changed.

CHAPTER 1 - THE FLIGHT OF BALLOONS

Key Physical Concept

This chapter introduces **thermal convection**: warm air is less dense than cold air and rises naturally. When a balloon's envelope fills with heated air, the upward force exceeds the balloon's weight, causing it to rise.

Students understand that a balloon's flight relies not on an engine but on a **difference in density between masses of air**. Altitude is controlled by adjusting the heat (and using a valve to descend).

Historical Figures and Anecdote

- Joseph Montgolfier (France, 1740–1810) and Étienne Montgolfier (France, 1745–1799): brothers who worked in the paper-making industry and, while observing smoke rising, conducted experiments that led to the first hot-air balloon flight.

- Did you know that…
  The very first flight carrying living creatures took place in September 1783 in Versailles, in the presence of King Louis XVI. The passengers were a sheep, a rooster, and a duck! Upon landing, the animals were alive and well, proving that even a groundliving creature like the sheep could survive high in the air.

CHAPTER 2 - BIRDS' WEIGHT AND FLIGHT

Key Physical Concept

This chapter explores **structural adaptations for flight**: birds have hollow bones (for lightness) and muscular wings capable of moving air to create lift. Students thus discover the relationship between **mass, wing area, and lift** (maintaining equilibrium).

The concept of **gliding** (flight without flapping wings) is introduced: the initial speed and the shape of the wings are sufficient to keep the flying object in the air for a certain amount of time.

Historical Figures and Anecdote

- Leonardo da Vinci (Italy, 1452–1519): In 1505, he wrote the *Codex on the Flight of Birds* and designed the ornithopter, a flapping-wing machine inspired by the anatomy of birds.

- Otto Lilienthal (Germany, 1848–1896): He made more than 2,000 gliding flights from a hill, paving the way for powered flight.

- Did you know that…
  Lilian Bland (Ireland/United Kingdom, 1878–1971) was a, a journalist who built the "*Mayfly*," a glider made of bamboo and canvas, then added an engine to create the first Irish aeroplane.
  She was the first woman in the world to design, build, and fly her own aeroplane!

CHAPTER 3 - LIFT AND FLIGHT OF AEROPLANES

Key Physical Concept
A key chapter on the **four forces of flight**:
Lift (↑)
Weight/Gravity (↓)
Thrust (→)
Drag (←)

Lift is an aerodynamic force produced by the wing's airfoil: when an airplane moves forward quickly, air flows differently over and under the wing, creating a **low-pressure area** above the wing that pulls it upward.

Students understand that an aeroplane, unlike a balloon, **can only fly if it is moving forward**: speed is a prerequisite for lift.

Historical Figures and Anecdote

- Wilbur Wright (United States, 1867–1912) and Orville Wright (United States, 1871–1948). Their numerous experiments led them to fly the Flyer, making the first controlled, powered aeroplane flight on December 17, 1903.

- Katharine Wright (United States, 1874–1929): Sister of the Wright brothers and key supporter/spokesperson for their work. She learned French to help manage

operations and present their aircraft in France in 1909

- Did you know that…
  Bessie Coleman (United States, 1892–1926): After being denied admission to American flight schools because of her race and gender, she moved to France and earned her pilot's licence in 1921. She became the first African American woman (and first Native American) to earn an international pilot's licence!

CHAPTER 4 - ROTORS AND HELICOPTERS

Key Physical Concept

Students learn about the principle of the **rotor**: spinning blades act like rotating wings that push air downward, producing an upward reaction (introducing Newton's third law intuitively). Unlike an aeroplane, a helicopter does not need forward momentum to fly.

The role of the **tail rotor** is explained: without it, the fuselage would spin in the opposite direction of the main rotor (rotational torque). The tail rotor counterbalances this torque to maintain stability.

Historical Figures and Anecdote

- Igor Sikorsky (Ukraine/United States, 1889–1972): the engineer who pioneered the modern helicopter with a single rotor stabilized by a tail rotor.
- The bamboo copter: a Chinese toy from the 4th century, the conceptual ancestor of the rotor, proof that the idea of rotary flight dates back to ancient times.
- Did you know that…
  Jules Verne and the Albatros (France, 1828–1905): In *Robur the Conqueror*, Jules Verne imagines a 30-metre flying ship propelled by 37 masts equipped with rotors. This imaginary flying object is reminiscent of today's drones.
  (See a replica model of the Albatros in flight https://youtu.be/GYhPw7zWucY?si=DEPCsuPJOvbvWavX)

QUIZ

The procedure is the same as at the beginning of the session, with a comparison of the results between the responses before and after the course.

FURTHER INFO

If you'd like, here is a list of notable figures whose stories can be explored to gain a deeper understanding of historical concepts:

- Louis Blériot (France's first licensed pilot, 1909)
- Élisa Deroche (first woman to receive a pilot's license, March 8, 1910)
- Marie Marvingt, known as "the fiancée of danger" (third French female pilot, creator of the air ambulance).

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