



Science and Innovation

A Boeing/Teaching Channel Partnership

SPY GLIDERS

Teacher Handbook



TeachingChannel®

Spy Gliders

Days 6 through 9: Construction, Testing, and Optimization

Grade Level	Middle School
Lesson Length	Four 50-minute sessions



Lesson Overview

On these planning, building, and testing days, students bring together what they learned about glider shape, payload, and construction materials as they work in teams to create their gliders. The teams start by creating labeled diagrams of their planned gliders. The diagrams should note what features they think will help their gliders meet the challenge's criteria and constraints. Once each team has presented their plan to the teacher and the class, the team can then begin to build. Students should have at least two days to build their gliders and allow for glue to dry.

On Days 8 and 9, students test their model gliders in the field. They begin by making predictions as to which gliders will travel the longest distance at the highest elevation. As the gliders are tested, each student records quantitative data about the distance traveled as well as any qualitative observations.



Connecting to the Next Generation Science Standards

On Days 6 through 9, students demonstrate understanding of the performance expectations and three dimensions developed throughout the entire module. This lesson serves as a performance assessment in which all of the performance expectations and dimensions are addressed in the final presentation. Reference the performance expectations, disciplinary core ideas, science and engineering practices, and crosscutting concepts referenced in the front matter of this module.



Basic Teacher Preparation

Ensure the required supplies are available and organized for the students. Make sure students know the safety precautions that should be taken while working with scissors and/or utility knives to cut the materials. Identify a safe area and establish a clear cadence for throwing the gliders. To ensure testing consistency, think of a way to ensure all teams throw in the same fashion, or identify a designated “thrower” to allow for a more equitable comparison. If possible, build a glider prior to class as a way to prepare to support students throughout the process.

Refer to the [Spy Gliders Student Handbook](#) ahead of time so you can address any questions students might have. All documents used on Days 6 through 9 are on pages 19 through 27 in the [Spy Gliders Student Handbook](#). The documents used in this lesson are:

- [6.1: Build Day](#) (page 19)
- [6.2: Conceptual Model](#) (page 20)
- [6.3: Build Day Debrief](#) (page 21)
- [8.1: Test Day](#) (page 22)

- 8.2: Test Day: Data Table (page 23)
- 9.1: Redesign and Retest (page 24)
- 9.2: Redesign and Retest: Data Table II (page 25)
- 9.3: Optimal Design (page 26)
- 9.4: Analysis of Results (page 27)

Required Preparation	Links/Additional Information
<input type="checkbox"/> Gather and set out all necessary materials	Refer to the Materials List below
<input type="checkbox"/> Review all videos and resources in the Suggested Teacher Resources	Refer to the Suggested Teacher Resources at the end of this lesson



Materials List

Item	Description/Additional Information	Quantity	Where to Locate/Buy
Standard 12" ruler		1 per student	Already used On Day 2
Foam (polystyrene) gliders	The longer the wing span, the better.	1 per team	Already used on Day 3
Paper clips	These can be used as fasteners or weights if you should use smaller gliders.	1 box per class	Already used on Day 3
Duct tape		1 roll per class	Already used on Day 3
Hot glue gun		1 for every 2 teams	Already used on Days 4 and 5
Balsa wood		1 per team	Already used on Days 4 and 5
Foam board		1 per team	Already used on Days 4 and 5
Scrap cardboard		1 large box per team	Already used on Days 4 and 5
Very fine sanding blocks		1 per team	Already used on Days 4 and 5
Scissors		1 per team	Available in schools or office supply stores
Utility knives (optional)		1 per team	Available at hardware stores

Copy paper		1 ream	Available in schools or office supply stores
Poster Paper	For student presentations on Day 6	1 per team	Available in most schools

Day 6: Construction, Testing, and Optimization



Introduction (10 minutes)

As a class, review the criteria and constraints previously established for the design challenge. Then have students refer to **6.1: Build Day** on page 19 in the **Spy Gliders Student Handbook** as they individually draw and label a detailed diagram of their final glider design. Be sure they include payload placement.



Design Work: Conceptual Model (15 minutes)

Instruct each student to share their design with other members of their team. Have them refer to **6.2: Conceptual Model** on page 20 in the **Spy Gliders Student Handbook** as they work together to develop a detailed team model to present to the class.



Whole Group Discussion: Presentation and Class Discussion (20 minutes)

Have students refer to **6.2: Conceptual Model** on page 20 in the **Spy Gliders Student Handbook**. Invite each team to present their idea, and elicit constructive feedback from the class. Have each team consider which suggestions and recommendations they want to incorporate into their final glider design.



Lesson Close (5 minutes)

Have students complete the **6.3: Build Day Debrief** reflection activity on page 21 in the **Spy Gliders Student Handbook**. As time allows, discuss as a class.

Day 7: Construction, Testing, and Optimization



Design Work: Retool Team Glider Design (10 minutes)

Instruct teams to use the feedback received after their presentations on Day 6 to update their glider designs. Review and sign off on each team's updated design blueprint.



Design Work: Glider Construction (40 minutes)

Working in teams, have students use the provided supplies to construct their gliders and conduct preliminary, undocumented flight tests. During these initial tests, students should focus on air worthiness and throwing methods.

Day 8: Construction, Testing, and Optimization



Introduction (10 minutes)

Instruct students to turn to **8.1 Test Day** on page 22 in the **Spy Gliders Student Handbook**. Have students respond to the writing prompt, which focuses on the design challenge's criteria and constraints, as well as the students' predictions. When finished, discuss as a class.



Design Work: Glider Testing and Data Collection (40 minutes)

Using the predetermined procedure, have student teams fly their gliders and gather data on **8.2: Test Day: Data Table** on page 23 in the **Spy Gliders Student Handbook**.

Engage students in a discussion regarding the engineering design process. Choose from some of the prompts below, or create your own prompts.

- *Why is it important to engage in multiple tests?*
- *What is the purpose of redesign?*
- *Why gather input from other's on your design?*
- *What types of engineers might be involved in the development of a real airplane? Why?*
- *How did the criteria and constraints impact your design?*
- *How might a varying payload (weight, height, width) affect your design?*
- *Why might building a scale model be important before constructing the final product?*
- *How did the four forces of flights affect each glider's flight?*
- *When engineers design and build something, does it usually work as intended the first time? Why or why not?*
- *What can we learn from failure?*
- *How does each team member's role affect the glider testing?*

Day 9: Construction, Testing, and Optimization



Introduction (10 minutes)

Instruct students to turn to **9.1: Redesign and Retest** on page 24 in the **Spy Gliders Student Handbook**. Have students respond to the prompt, which focuses on design strengths and failure points. Afterwards, discuss as a class.



Design Work: Optimize and Retest Gliders (20 minutes)

Allow the student teams to redesign and fly their optimized gliders. Have students gather data using the **9.2: Redesign and Retest: Data Table II** on page 25 in the **Spy Gliders Student Handbook**. Afterwards, have students complete **9.3: Optimal Design** on page 26 in the **Spy Gliders Student Handbook**.



Extension

Once the gliders prove to be air worthy, experiment with the placement of the added dummy weight. Once that design is optimized, the camera should be added to the body of one of the more successful gliders. At that point, the fully equipped glider can be flown from a high spot (upper story window, top of the bleachers, weather balloon, or other location) on school grounds to capture footage that can be shared with the entire class.



Design Work: Analyze and Make Inferences (20 minutes)

Direct students to analyze their testing results on **9.4 Analysis of Results** on page 27 in the **Spy Gliders Student Handbook**. Instruct students to reflect on their previous drawings, and then identify and write at least three modifications to their glider design. They should also provide reasoning for the modifications based on testing evidence. Have students predict how each modification might impact test results.



Assessment

Several opportunities for formative assessment exist in this lesson:

- **Spy Gliders Student Handbook** entries can be used to monitor student progress during the module. For this lesson, focus on all Days 6 through 9 documents to monitor student progress.
- Consider using the **Collaborative Work Skills Rubric (Appendix D)** to assess student collaboration.

- Whole class share-outs and discussions allows for formative assessment of student ideas and building content knowledge.
- When students are meeting in their teams, spend time with each team, listening in on their process and providing support as needed.

Use the identified assessment opportunities to monitor student progress on disciplinary core ideas, science and engineering practices, and crosscutting concepts. Provide appropriate supports or extensions when necessary.

Reference [Appendix B](#) for suggestions for meeting the needs of all learners.



Community Connections

Days 6 through 9 provide excellent opportunities for parents, community partners, and other adults to assist with student work. Additional adults can help monitor student activity during the design and testing stages.



Suggested Teacher Resources

Meeting the Needs of All Learners	Spy Gliders Teacher Handbook, Appendix B
Collaborative Work Skills Rubric	Spy Gliders Teacher Handbook, Appendix D