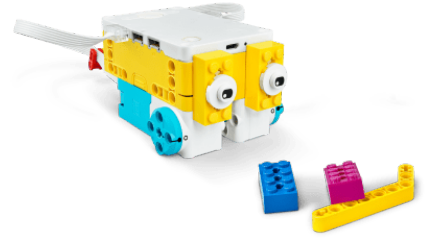


Hopper Race

Design multiple prototypes to find the most effective way to move a robot without using wheels.

🕒 30–45 min. 📦 Beginner 🎓 Grades 6–8



Teacher Support

Key objectives

Students will:

- Explore the process of creating prototypes to solve a problem

Things you will need

[LEGO® Education SPIKE™ Prime Set](#)

Additional resources

[Building instructions \(Hopper\)](#)

[Building instructions \(Grasshopper\)](#)

[Python Programs](#)

Educational standards

NGSS

MS-ETS1-1.

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Common Core

CCSS.ELA-LITERACY.SL.6.1.C

Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.

CCSS.MATH.CONTENT.6.EE.B.7

Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p , q and x are all nonnegative rational numbers.

Lesson plan

1. Prepare

- Read through the student material in the LEGO® Education SPIKE™ App.

2. Engage (5 Min.)

- Use the ideas in the *Ignite a Discussion* section below to engage your students in

a discussion related to this lesson.

- Use the video to explain the lesson.

3. Explore (25 Min.)

- Have your students in pairs to build the hopper model.
- Ask them to play the program to see how the hopper moves.
- Have them prototype new legs to move the hopper's body forward faster.
Highlight that they cannot use wheels for locomotion.

4. Explain (5 Min.)

- Facilitate a discussion by asking the students to describe the methods they've used to improve their hopper's movement.

5. Elaborate (10 Min.)

- Prepare the test track by setting up start and finish lines using LEGO bricks.
- Give the teams 5 minutes to test and improve their models before the final race.
- If time allows, encourage them to give their hoppers some character by adding bricks and other materials from around the classroom. They can also place bricks on the test track, creating an uneven surface that's more difficult to walk over.
- Don't forget to leave some time for cleanup.

6. Evaluate

- Give feedback on each student's performance.
 - You can use the assessment rubrics provided to simplify the process.
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Ignite a Discussion

Start a discussion about prototyping by asking relevant questions, like:

- What's a prototype?
- What's the benefit of having multiple options for a solution?
- How do you usually generate ideas before prototyping them?
- Have you ever prototyped an idea? How did you do it?

Have your students watch this video to see what they're about to do.

Building Tips

Create Original Solutions

There are almost infinite solutions to this problem and this lesson is an opportunity for your students to really think outside the box. Once they think they've found the best solution, challenge them to find another one.

Race Against the Teacher

Challenge your students to outrun your grasshopper! Use this example to demonstrate how your students can design nimble legs and add character to their hoppers.

Let Inspiration Flow

Have your students share their best prototypes. This is guaranteed to increase the iteration cycle, and their motivation to build the fastest hopper!

Suggest elements for further exploration, such as:

- Length of the legs or stride
 - Motor speed
 - Walking surface (there's less friction on a smooth tabletop)
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Coding Tips

Main Program

Differentiation

Simplify this lesson by:

- Exploring idea generation using the *Ideas, the LEGO Way* lesson

Take this lesson to the next level by:

- Making the test track uneven by adding loose bricks between the starting line and finish line (changing the criteria for the race)
 - Incorporating the math or language arts extension(s)
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Assessment Opportunities

Teacher Observation Checklist

Create a scale that matches your needs, for example:

1. Partially accomplished
2. Fully accomplished
3. Overachieved

Use the following success criteria to evaluate your students' progress:

- Students can describe the problem they're trying to solve.
- Students have generated various ideas for solving the problem.
- Students have designed, even if not functioning, multiple solutions to the problem.

Self-Assessment

Have each student choose the brick that they feel best represents their performance.

- Blue: I've prototyped one functioning set of legs.
- Yellow: I've prototyped two or more functioning sets of legs.
- Violet: I've modified my prototypes several times and have improved the efficiency of my hopper.

Peer-Assessment

Encourage your students to provide feedback to others by:

- Having one student score the performance of another using the colored brick scale above.
- Asking them to present constructive feedback to each other so that they can improve their group's performance during the next lesson.

Language Arts Extension

To incorporate language arts skills development:

- Have your students produce a presentation about biomimetics.
- Ask them to describe how their hopper is biomimicking the movement of an animal.

Note: This will make for a longer lesson.

Math Extension

To incorporate math skills development:

- Have your students find the speed of their hopper in cm/sec (or in/sec).
- Have them figure this equation for their hopper:

$$\text{Distance traveled} = \text{Speed} * \text{Time}$$

- Have them predict the distance their hopper would travel after 8, 16, and 24 seconds.

Note: This will make for a longer lesson.

Career Links

Students who enjoyed this lesson might be interested in exploring these careers pathways:

- Manufacturing And Engineering (Pre-Engineering)
- Media And Communication Arts (Digital Media)
- Transportation (Automotive Technology)