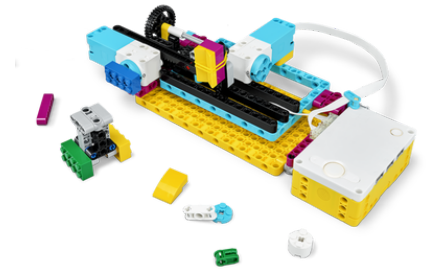


Broken

Figure out why something isn't working and fix it

🕒 45–90 min. 📦 Advanced 🎓 Grades 6–8



Teacher Support

Key objectives

Students will:

- Evaluate the performance of a design solution
- Iterate to find problems, then fix them

Things you will need

[LEGO® Education SPIKE™ Prime Set](#)

Pencils

Additional resources

[Building instructions](#)

[Building instructions](#)

[Paper template for CNC \(print with no resize\) \(PDF\)](#)

[Python Programs](#)

Educational standards

NGSS

MS-ETS1-3

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Common Core

CCSS.ELA-LITERACY.SL.6.2

Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

CCSS.MATH.CONTENT.6.RP.A.1

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

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 (35 Min.)

- Have your students work in pairs to build the CNC machine, have them keep in mind that they're building a non-functioning machine.
- Ask them to run the program and to try to identify and correct the issues they see.
- Remind them to document the problems and their solutions.

4. Explain (10 Min.)

- Facilitate a sharing session. Encourage your students to talk about the problems they found and the solutions they came up with.

5. Elaborate (25 Min.)

- Ask each team to improve their CNC machine by modifying their build and/or program.
- Have them take turns sharing their improvements with the class.
- 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.
-

Ignite a Discussion

Start a discussion about iteration or fixing things by asking relevant questions, like:

- What's usually your first reaction when something breaks?
- If you're going to fix something, what will you do first?
- What's the last thing you've fixed? How did you find the problem?
- What's a CNC machine? Do you know what it's used for?

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

Building Tips

Tandem Build

Split each team's building tasks to ensure that everybody is actively involved:

- Student A: top of the CNC machine

- Student B: bottom and needle of the CNC machine

Pre-designed shapes

You can use blank sheets of letter-size paper for this lesson but pre-designed PDFs of CNC cuts are provided. By using these pre-designed sheets, it'll be easier for your students to figure out whether or not the CNC works.

Loading the Paper

Here's how you load the paper:

Looking for Issues

The CNC machine model has 4 real issues that must be fixed in order for the program to work as intended:

1. A paper feeder wheel is missing, causing the Y axis to not work properly.
2. The top of the CNC machine isn't correctly attached to the bottom.
3. The paper feeder gears are inverted, causing the paper to enter the CNC too quickly.
4. The pencil carriage isn't affixed, causing the X axis to work improperly.

Easy Fixes

Here's the easiest way to fix these issues, though keep in mind that the objective of this lesson is for your students to find their own solutions.

Possible Upgrade

Your students can upgrade their CNC machines by adding a Color Sensor.

Coding Tips

Main Program

Possible Solution

Differentiation

Simplify this lesson by:

- Suggesting a selection of bricks your students can use to fix the issues
- Asking all of the teams to work on the same upgrade so it's easier to assess the improvements

Take this lesson to the next level by:

- Having your students draw complex shapes on the printer, including curves
 - Having your students transform this model into a 3D printer by adding a Z axis
-

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 function of an object.
- Students can describe the benefit of an object's features against needs.
- Students can construct effective arguments.

Self-Assessment

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

- Blue: I can describe how things work
- Yellow: I can describe in detail how things work and I can highlight what it's good at.
- Violet: I can convince someone that I've invented the coolest thing in the world.

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 work hands-off to role-play calling a customer support line.
 - ▷ One student describes the problem.
 - ▷ The other student explains how to fix it.

Note: This will make for a longer lesson.

Math Extension

To incorporate math skills development:

- Have your students find the gear ratio of the paper feed.
- Ask them to use appropriate language to describe how it controls the speed of the paper entering the CNC.
- Have them explain (and try!) what would happen if the gears were swapped.

Note: This will make for a longer lesson.

Career Links

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

- Business And Finance (Entrepreneurship)
- Education And Training (Teaching)
- Media And Communication Arts (Broadcast Technology)