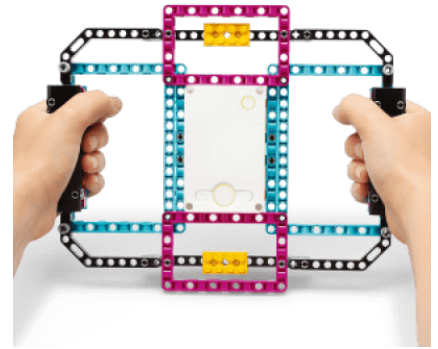


Stretch with Data

Match graph values and explore margins of error qualitatively.

🕒 30–45 min. 📦 Advanced 🎓 Grades 6–8



Teacher Support

Key objectives

Students will:

- Create a program to be introduced to the LEGO® Education SPIKE™ Prime line graphing tool
- Graph real sensor data
- Correlate graph curves with real-life movement

Things you will need

- LEGO Education SPIKE Prime Set
- Device with the LEGO Education SPIKE App installed

Additional resources

[Building instructions \(Yoga Ring model\)](#)

[Sample data for the lesson](#)

[Sample data for the math extension \(optional\)](#)

[Student Inventor Notebook](#)

Educational standards

NGSS

MS-ETS1-4

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Common Core

CCSS.MATH.CONTENT.7.RP.A.2

Recognize and represent proportional relationships between quantities.

CCSS.MATH.CONTENT.8.F.A.3

Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

CCSS.ELA-LITERACY.SL.8.4

Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

CCSS.ELA-LITERACY.SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

CSTA

2-CS-01

Recommend improvements to the design of computing devices, based on an analysis of how users interact with the devices.

2-CS-02

Design projects that combine hardware and software components to collect and exchange data.

2-DA-09

Refine computational models based on the data they have generated.

ISTE

4a

Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

4b

Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

4c

Students develop, test and refine prototypes as part of a cyclical design process.

5b

Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

5d

Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

Hybrid learning resources

[5 Ideas and examples for Blended Learning Using the 5E Model](#)

Prepare for Blended Learning

(Before Class)

- If you feel it's needed, plan a lesson using the getting started material in the app. This will help familiarize you and your students with SPIKE Prime.
- Make sure to watch the lesson video on this page.
- Read through the student material for this lesson via the link on this page, or in the SPIKE App.
- You might want to consider:
 - Choosing the right tool(s) and the right place. For example, watching videos, reading a textbook, or preparing for a hands-on experience can easily be done at home. Performing the experiment and collecting data "hands-on" is easier in a classroom setting.
 - Using a variety of tools and allowing for broad differentiation. This will increase your students' engagement and improve learning outcomes.
 - Providing various methods of virtual collaboration. Here are some examples:
 - Videoconferencing
 - Blogs, chats, or wall posts
 - Digital versions of student worksheets
 - Adapting the lesson flow to account for not being a classroom setting throughout the entire lesson. We've provided an example lesson flow below.
- Here are other ways to adapt the lesson flow to your student needs:

- Have your students watch the videos describing what they're about to do. You can point them to the SPIKE App or use the student worksheet URL.
 - Use any other material you may have already prepared on the topic.
 - Customize the Student Inventor Book to have your students prepare their learning experience and reflect on their findings. (see Additional Resources)
 - Use the Lesson Briefs (an easy-to-use lesson overview printable 1-pager) to inspire your students with an open ended challenge. (see Additional Resources)
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Engage

(Before Class, 20 Min.)

- In this lesson, your students will stream *pitch*, *roll*, and *yaw* data values to trace a line graph in real time. They'll use this graph to coordinate their movements, matching their streamed data to a pre-recorded graph.
- The *pitch*, *roll*, and *yaw* data values describe the tilt angle of an object in relation to its 3 axes:
 - Pitch - tilt on the y-axis
 - Roll - tilt on the z-axis
 - Yaw - tilt on the x-axis
- Use various materials to engage your students on the topic of *pitch*, *roll*, and *yaw* data values.

Ignite a Discussion

Start a discussion by asking questions related to the lesson. Here are a couple of suggestions:

- What are some ways of determining whether or not a movement is precise?
- How could you graph values to represent real-life movement?

Have your students write down their thoughts as a hypothesis.

Explore

(In Class, 30 Min.)

- Have your students build a yoga ring. They can create their own models, or follow the building instructions in the app to build the Yoga Ring model

Follow the building instructions in the app to build the Yoga Ring model.

- Explain that this device will record the pitch-roll-yaw angle values for various movements.
 - Ask your students to try out their models using the suggested program in the SPIKE App. For the first movement, they'll bring the ring from a front facing position (Hub LED Matrix facing student eyes) to the top of their head (see video).
 - Tell them to look at the pitch angle on the graph over time and document what they see.
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Explain

(In Class, 15 Min.)

- Allow your students some time to adjust their programs to track other values.
 - Have them try to match the second graph, which is preloaded in the line graph, with their movements.
 - Make sure they realize that the speed of movement will affect the "shape" of the graph.
-

Elaborate

(After Class, 20 Min.)

- If your students still have access to their SPIKE Prime Sets, have them complete the tasks from the SPIKE App, to elaborate with hands-on learning, for example:
 - The last preloaded graph uses two values at the same time. Your students have to combine both moves into one long stretching session.
 - If your students don't have access to their sets, have them complete their Student Inventor Notebook, or assign one of the extension activities suggested below. Most of the extension activities can be done using the data collected during the hands-on session
 - Facilitate a sharing session in which your students exchange their thoughts and the results of their experiments. This can be done using whichever method/tool is most efficient (i.e., in-person or online).
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Evaluate

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

Teacher Observation Checklist

Establish a scale that meets your needs, for example:

- Partially accomplished
- Fully accomplished
- Overachieved

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

- The students can program a device to log data on a line graph.
- The students can correlate the movement of a physical device to the line graph it's generating.
- The students can explain the concepts of *pitch*, *roll*, and *yaw*.

Self-Assessment

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

- Blue: I can graph data using the program provided in the app.
- Yellow: I can create my own experiment using a line graph.
- Violet: I can create my own experiment, use a line graph, and draw conclusions from the graph.

Peer-Assessment

Encourage your students to give 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 performance during the next lesson. This is a great opportunity to use videoconferencing tools or blog posting tools in a blended learning scenario.
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Differentiation

Simplify this lesson by:

Ask students to create a line graph of their own design and use it to track their progress.

- Asking your students to recreate the experiment using only the Hub, by holding the Hub in the correct position to do this lesson
- Making sure that your students adjust the suggested program in the SPIKE app to match their model configuration.

Take this lesson to the next level by:

- Asking your students to build their own yoga rings
 - Having your students record a partner's yoga movements on a graph, share their graphs, then try to replicate each other's movements by following the graph data
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Tips

Building Tips

Coding Tips

Using Streaming Mode

This lesson is designed to be played in Streaming Mode. In that mode, the data collected by the Hub is streamed directly to your device, and traced in real-time on the Line Graph.

Main Program

Science Data Tips

Here is an example of the data students can expect from this experiment.

Extensions

Math Extension

To incorporate the development of math skills:

- Using the sample data available for this lesson (or your own data), have your students describe what's happening with regard to movement when the graph shows a straight line, and when it shows a curve.
- Have your students find the math expression under the form $y = mx + b$ for a line

portion of their graph, in the sample data or in the data .

- Have your students find these first degree equations ($y=mx+b$) both manually and using a digital tool.

Note: This will require additional time.

Language Arts Extension

To incorporate the development of language arts skills:

- Have your students use digital media to explain this lesson and their findings.

They could do this by:

- Producing a video
- Posting pictures and comments via a learning management system (if available)
- Contacting with a yoga instructor to research whether a device like the Yoga Ring model could be useful

Note: This will require additional time.

Career Links

Students who've enjoyed this lesson might be interested in exploring these career pathways:

- Therapeutic Services
- Engineering and Technology