LEGO® Education
Integrated STEM Education
Research Collaborations

Massachusetts Institute of Technology
Through the Media Lab’s Lifelong Kindergarten Group

University of Cambridge
Through the Research Centre on Play in Education, Development and Learning (PEDAL)

Tsinghua University
Lifelong Learning Lab

Harvard University
Through the Centre on the Developing Child and Project Zero

Aarhus University
Centre for Child Research, Inst. for Education and Pedagogy, Mind Lab

BRAC University
Centre of Play at the Institute for Education Development
The philosophy behind LEGO® MINDSTORMS® is to allow children not only to understand technology but also to become creative masters of it. This happens when they design, construct, and program their own intelligent inventions.

KJELD KIRK KRISTIANSEN
LEGO OWNER FAMILY

Children learn best when they are actively engaged in constructing something that has a personal meaning to them – be it a poem, a robot, a sandcastle, or a computer program.

SEYMOUR PAPERT
PROFESSOR OF LEARNING RESEARCH, MIT
Challenge with student confidence remains top of mind

3 out of 4 educators say anxiety and lack of confidence hinder learning among their students.

Only 1 in 3 educators say their students are more confident in STEAM subjects compared to 5 years ago.

Fewer than 1 in 5 students are “very confident” when it comes to learning STEAM.

47% of students say that they avoid subjects where they’ve failed before.

47% of students say their students are more confident in STEAM subjects compared to 5 years ago.

Half of students today say trying new things at school makes them nervous.
Building confidence with active, hands-on STEAM learning

95% of educators believe the number 1 way their students can build confidence in STEAM subjects is working on hands-on projects with others.

93% of parents believe the number 1 way their students can build confidence in STEAM subjects is working on hands-on projects with others.

57% of students say they need “hands-on experience and tools” to master STEAM subjects.

87% of students say they tend to remember the topics longer when learning through hands-on projects.

89% of students say that hands-on learning helps them learn new things (and thus makes them more confident in learning new things).

Students who are confident in learning STEAM subjects are more than twice as likely to say they were confident in school today.

(82% confident in STEAM compared to 33% not confident in STEAM)
LEGO Education pedagogy

**Learning through play**
Joyful | Socially interactive | Actively engaging | Meaningful | Iterative | Our brain’s favorite way to learn

**Key educational methodologies**
Constructivism | Constructionism

**21st Century skills and the 5 Es**
Creativity & innovation | Critical thinking | Communication | Collaboration | Engage | Explore | Explain | Elaborate | Evaluate
LEGO® Education SPIKE™ Prime

ACCELERATE STEAM LEARNING FOR YOUR ENTIRE CLASS WITH A NEW, INCLUSIVE, HANDS-ON SOLUTION
Solution Components

Unit plans
Bricks
Intelligent hardware
Coding

Professional development & teacher training
Develop Abstract Thinking in 6th - 8th Grades

**STEAM**

**Invention Squad**
Using the design engineering process

**STEAM**

**Kickstart a Business**
Applying and developing computational thinking skills

**STEAM**

**Life Hacks**
Working with data representation and manipulation

**STEAM**

**Competition Ready**
Getting ready for competitions and challenges
Lessons

Help!
LEGO® Education SPIKE™ Prime Set
Define a problem by observing a scenario.

STeAM, Engineering
20-45 min, beginner, grades 4-6

Hopper Race
LEGO® Education SPIKE™ Prime Set
Design multiple prototypes to find the most effective way to move a robot without using wheels.

STeAM, Engineering
20-45 min, beginner, grades 4-6

Super Cleanup
LEGO® Education SPIKE™ Prime Set
Test the efficiency of two different grabber designs and determine the best design based on specific test criteria.

STeAM, Engineering
20-45 min, beginner, grades 4-6

Broken
LEGO® Education SPIKE™ Prime Set
Figure out why something isn’t working and fix it.

STeAM, Engineering
40-60 min, beginner, grades 4-6

Design for Someone
LEGO® Education SPIKE™ Prime Set
Use the complete design process to solve a real-world problem linked to prostheses.

STeAM, Engineering
120+ min, intermediate, grades 4-6
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.

Teacher Support

Key objectives

Things you will need

Additional resources

Educational standards

NGSS
M9-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.8.2
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.8.RP.A.1
Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
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 benefits 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 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-on to role-play calls 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)
LEGO® Education - Learning Continuum

PRESENTS A CLEAR PATHWAY TO BUILDING THE RIGHT SKILLS FOR STUDENT SUCCESS

EARLY LEARNING
- STEAM Park
- Coding Express
- and many more

PRIMARY
- WeDo 2.0
- Early Simple Machines
- Simple Machines

SECONDARY
- LEGO® Education SPIKE™ Prime
- LEGO® MINDSTORMS® Education EV3
- Simple & Powered Machines
**FIRST® LEGO® League competitions**

Bring the fun to STEM learning, with hands-on, creative challenges that promote problem solving and team spirit.

**FIRST LEGO® League JR.**
- **Participants:** 86,000+
- **Teams:** 14,300
- **Models:** 14,300
- **Events:** 454
- **Countries:** 41

**FIRST LEGO® League**
- **Participants:** 280,000+
- **Teams:** 35,200
- **Models:** 35,200
- **Events:** 1455
- **Countries:** 85
THANK YOU

Spasiba
Merci Beaucoup
Gracias
Grazie
Danke Sehr
Tak
감사합니다
ありがとうございます
Bedankt