

# NEXT STEPS WITH LEGO® MINDSTORMS® EDUCATION EV3



[LEGOeducation.com/MINDSTORMS](http://LEGOeducation.com/MINDSTORMS)

 **MINDSTORMS**  
education **EV3**

## Next Steps with LEGO® MINDSTORMS® Education EV3

Develop your skills and integrate LEGO MINDSTORMS EV3 into your teaching.

Congratulations! You have completed the first step in exploring this new teaching tool and now you are ready to take the next steps.

This document outlines what you should do next, and provides six lessons for you to try with your students. Below, you can see an overview of what you will find in the next pages.

<b>1</b> Explore Curriculum Coverage page..... <b>3</b>	<b>5</b> Provide Frequent Feedback During a Lesson page..... <b>10</b>	<b>9</b> Explore More Projects page..... <b>21</b>
<b>2</b> Use Tutorials to Build Confidence page..... <b>7</b>	<b>6</b> Integrate Formal Assessment page..... <b>12</b>	<b>10</b> Create a Playing Surface page..... <b>21</b>
<b>3</b> Create a Learning Sequence Using Tutorials page..... <b>8</b>	<b>7</b> Integrate Formal Assessment during a lesson page..... <b>14</b>	<b>11</b> Customize Your Lessons page..... <b>22</b>
<b>4</b> Provide Frequent Feedback page..... <b>9</b>	<b>8</b> Use STEM Lessons in Your Classroom page..... <b>16</b>	<b>12</b> Get More Support page..... <b>23</b>

## 1. Explore Curriculum Coverage

Using LEGO® MINDSTORMS® Education EV3 in your classroom opens up the possibility for a variety of successful learning outcomes. Skills such as teamwork, creativity, and problem-solving are an inherent part of the experience, and students' natural mastery of digital technologies will help them to rapidly learn the language of programming.

Below is a selected overview of standards that are addressed or partially-addressed when using LEGO MINDSTORMS Education EV3. This list will grow steadily as you expand the use of EV3 in your classroom.

### *Practices*

- Asking questions
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

**NGSS**

### *Computational Thinking*

- Recognize that software is created to control computer operations
- Understand and use the basic steps in algorithmic problem-solving
- Develop a simple understanding of an algorithm

### *Computing Practices and Programming*

- Use technology resources for problem-solving and self-directed learning
- Construct a program as a set of step-by-step instructions to be acted out
- Implement solutions to problems using a block-based visual programming language

### *Computers and Computing Devices*

- Use standard input and output devices to successfully operate computers and related technologies
- Apply strategies for identifying simple hardware and software problems that may occur during use
- Identify factors that distinguish humans from machines
- Recognize that computers model intelligent behavior (as found in robotics, speech and language recognition, and computer animation)

**CSTA**

*Creativity and Innovation*

- Demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology
- Apply existing knowledge to generate new ideas, products, or processes
- Use models and simulations to explore complex systems and issues

*Communication and Collaboration*

- Use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others
- Contribute to project teams to produce original works or solve problems

*Critical Thinking, Problem-Solving, and Decision Making*

- Use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources
- Plan and manage activities to develop a solution or complete a project
- Collect and analyze data to identify solutions and/or make informed decisions
- Use multiple processes and diverse perspectives to explore alternative solutions

*Digital Citizenship*

- Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity
- Demonstrate personal responsibility for lifelong learning

*Technology Operations and Concepts*

- Demonstrate a sound understanding of technology concepts, systems, and operations
- Understand and use technology systems
- Select and use applications effectively and productively
- Troubleshoot systems and applications
- Transfer current knowledge to the learning of new technologies

*The Nature of Technology*

- Develop an understanding of the characteristics and scope of technology
- Develop an understanding of the core concepts of technology

*Design*

- Develop an understanding of the attributes of design
- Develop an understanding of engineering design
- Develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem-solving

*Abilities for a Technological World*

- Develop the ability to apply the design process
- Develop the ability to use and maintain technological products and systems

## ITEEA Standards for Technological Literacy

*Practices*

- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning
- Model using mathematics
- Use appropriate tools strategically

*Expressions and Equations*

- Solve real-life and mathematical problems using numerical and algebraic expressions and equations

*Geometry*

- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume

## Common Core Mathematics Standards

*Reading Standards for Literacy in Science and Technical Subjects*

- Precisely follow a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks
- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to texts and topics in grades 6–8

*Reading Standards for Informational Text*

- Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently

*Speaking and Listening Standards*

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and clearly expressing their own ideas

**Common Core English Language Arts**

**Curriculum Grid**

Introduction

**Next Generation Science Standards**

• = addresses standard

	ENERGY	Energy Transfer	Solar Energy	Energy Efficiency	Electric Vehicles	FORCE AND MOTION	Gears	Inclined Plane	Friction	Velocity	Acceleration of Gravity	LIGHT	Light Intensity	HEAT AND TEMPERATURE	Freezing and Thermal Insulation	Heat Transfer	Convection
<b>Practices</b>																	
1	Asking questions	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
2	Developing and using models	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3	Planning and carrying out investigations	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
4	Analyzing and interpreting data	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
5	Using mathematics, Informational and Computer Technology, and computational thinking	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
6	Constructing explanations and designing solutions	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
7	Engaging in argument from evidence	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
8	Obtaining, evaluating, and communicating information	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<b>Cross-cutting Concepts</b>																	
1	Patterns	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
2	Cause and effect: Mechanism and explanation	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3	Scale, proportion, and quantity	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
4	Systems and system models	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
5	Energy and matter: Flows, cycles, and conservation	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
6	Structure and function	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
7	Stability and change	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<b>Core Ideas: Physical Science</b>																	
PS1	Structure and Properties of Matter	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PS2	Motion and stability: Forces and interactions	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PS3	Energy	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

For learning grids mapping each of our Curriculum Packs to current curriculum standards, download the pack(s) or visit:

[www.legoeducation.com](http://www.legoeducation.com)

## 2. Use Tutorials to Build Confidence

The tutorials provided in the software will help to build your confidence and your students' confidence. Take some time to browse through them and identify the ones you might be interested in using.

Here is an overview of the tutorials that are available.

### Basics (Driving Base)

Learn how to control the Driving Base and trigger events based on input from the various sensors.

## For EV3 Lab Only

### Basics (Hardware)

Familiarize yourself with the Intelligent EV3 Brick and its assorted sensors and motors.

### Beyond Basics (Driving Base)

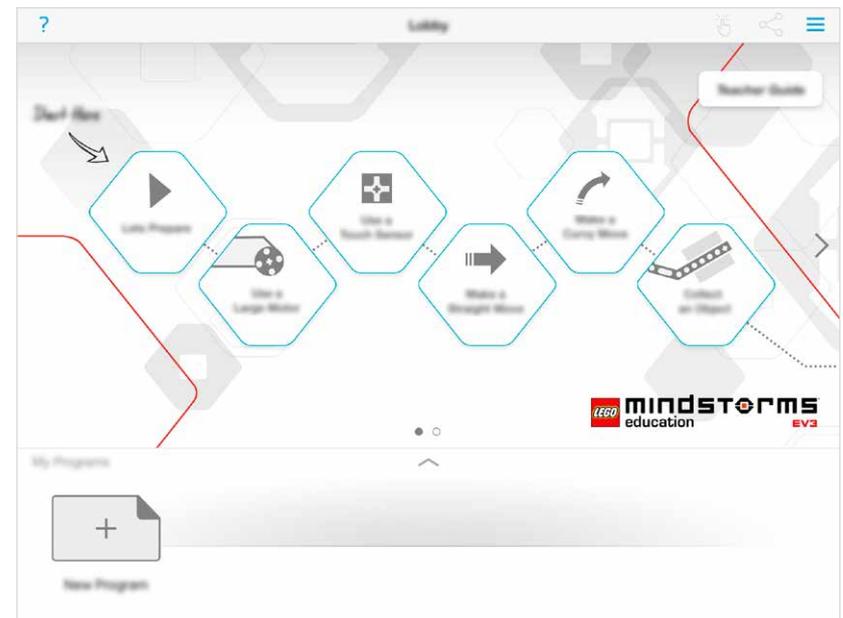
Grasp the fundamentals of more complex topics, such as program loops, switches, multiple switches, arrays, and data wires.

### Data Logging

Master various Data Logging concepts, such as live and Remote Data Logging, Graph Programming, and Dataset Calculation.

### Tools

Learn how to use the various tools that are available to your students, such as the Sound Editor and the Display Image Editor.



### 3. Create a Learning Sequence Using Tutorials

A good way to learn about the functionality of the EV3 Brick is to explore the Robot Educator tutorials and to combine two or three of them to create a learning sequence.

When designing your own learning sequences, remember to allow time for:

- Building the robot, if it is not already built
- Programming the robot
- Tinkering

#### Example of a Learning Sequence Using Tutorials

Explore the functionality of the Color Sensor by making different things happen based on the color detected by the sensor:

- **Color Sensor Color > Multiple Switch**

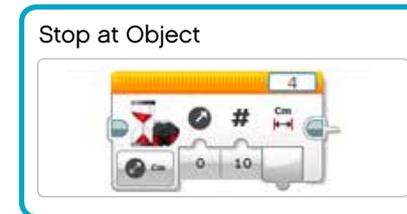
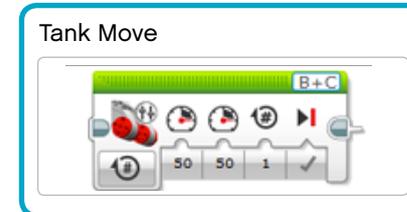
#### Examples of other Learning Sequences for EV3 Lab Only

Explore the functionality of the Color Sensor, and practice logging ambient light values:

- **Color Sensor Light > Remote Data Logging**

Explore math-related concepts:

- **Stop at Object > Range**
- **Variables > Arrays**



The learning sequence used in the LEGO® MINDSTORMS Education EV3 “getting started” experience.

## 4. Provide Frequent Feedback

Encourage your students to tell their learning story. Give the opportunity to share their thinking, ideas, and reflections. This will boost their confidence and engagement.

### Student Documentation

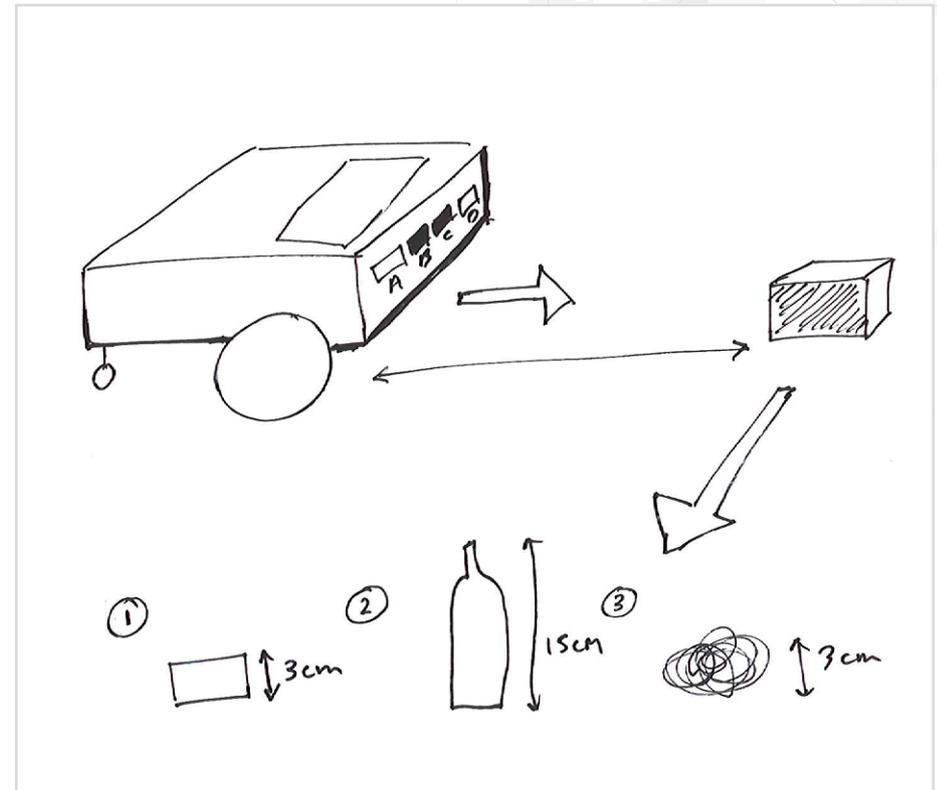
Have your students document their work. By doing that, students will reflect on and consolidate what they have just learned. They will also have to consider how to use appropriate language to communicate their thoughts and ideas.

### Using the Content Editor as a Documentation Tool

The Content Editor allows students to document their progress and findings as they work through each tutorial.

They can use the Content Editor to:

- Write full descriptions of their working processes
- Insert their own pages
- Add images and videos of their robot in action
- Share their unique project with other students



You can also allow students to select the tool(s) they find most appropriate for capturing and sharing their ideas. Encourage them to document their thoughts using text, videos, images, sketchnotes, or another creative medium.

## 5. Provide Frequent Feedback During a Lesson

### Move an Object

(45 minutes)

#### Objective

After completing this lesson, students will be able to:

- Program their robots to move and release objects of different shapes and sizes
- Optimize the performance of a design by prioritizing criteria, making trade-offs, testing, revising, and retesting

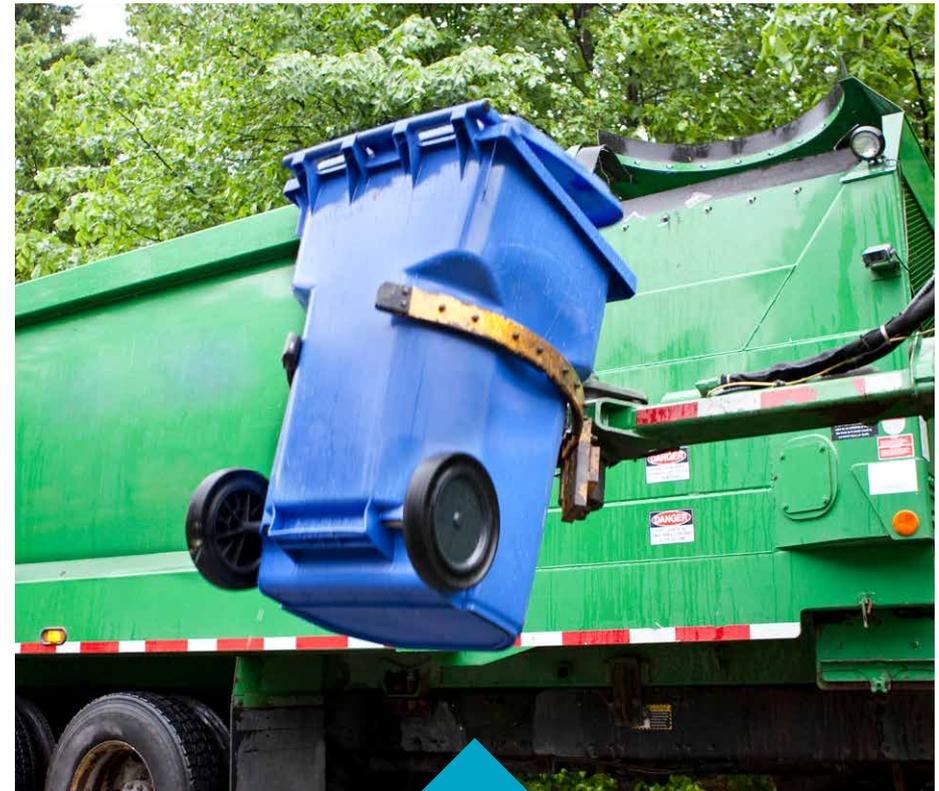
#### Setup

Define a starting position and and arrange various objects for the students to collect using their robots. Use objects of various shapes and sizes like those shown below.



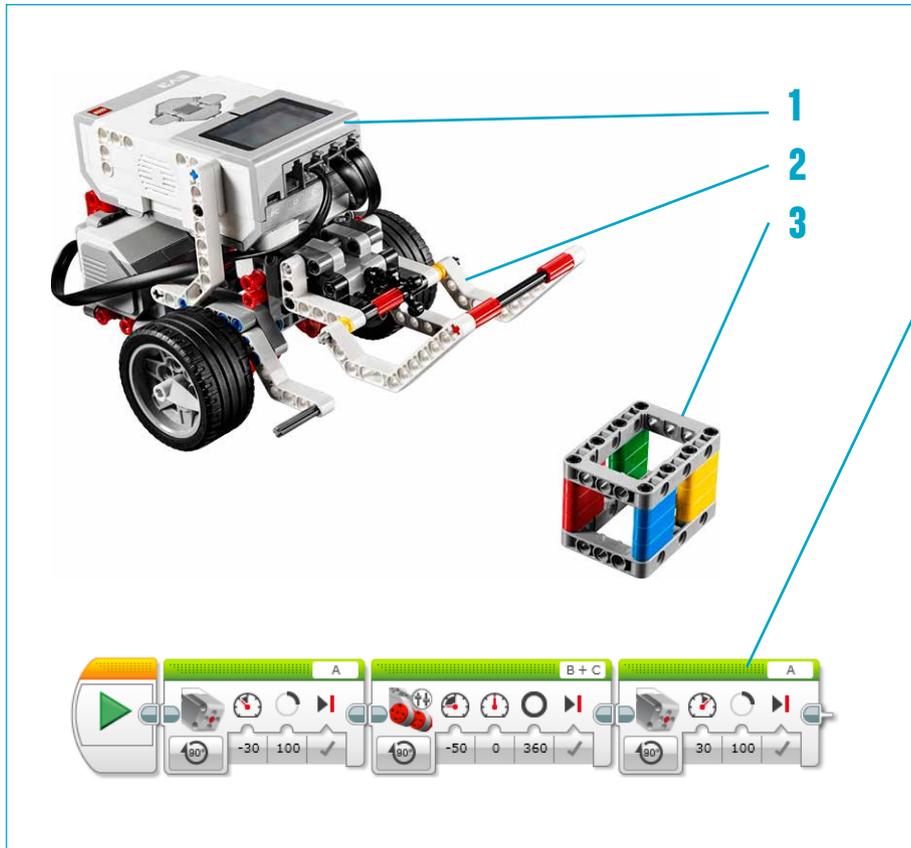
#### Feedback

During the lesson, interact with each student to identify any difficulties they are having in completing the task. Help them to improve by providing frequent feedback.



### A. Connect

Clean up your school by collecting objects of different shapes and sizes. Find ways to collect as many objects as possible.



## B. Construct

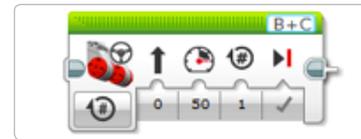
### Build

1. Driving Base
2. Robot Arm
3. Cuboid

### Program

Try to grab the Cuboid using the Robot Arm.

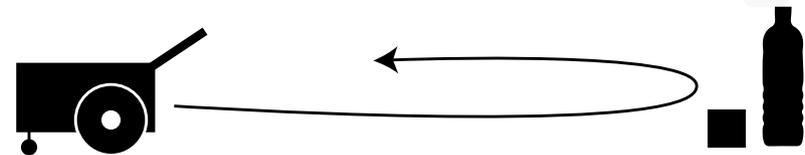
### Move Object



If you need help, watch the “Move Object” tutorial.

## C. Contemplate

- Have students collect the Cuboid and return it to the robot's initial position.
- Then have them collect a different object, and observe how they adapt to the change of task.



### Discussion Questions

#### Robot Behavior

How did you overcome the challenge of moving different objects?

*Modified the medium motor module frame to fit the bigger objects.*

## D. Continue

Use the project ideas provided in this document or refer to some of our Curriculum Packs for additional ideas.

## 6. Integrate Formal Assessment

### Teacher-Led Assessment

Developing students' science, engineering, and computational thinking skills requires time and feedback. Just as in the design cycle, in which students should understand that failure is part of the process, assessment should provide feedback in terms of what the students did well and where they can improve. Problem-oriented learning is not about success or failure. It is about being an active learner and continually building upon and testing ideas.

Giving feedback to students in order to help them develop their skills can be done in various ways. We have provided examples of rubrics that can be completed based on:

- Observation of students' behavior, reactions, and strategies
- Asking the students questions about their thought processes

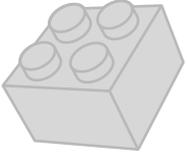
As students often work in groups, you can give feedback both on a team level and on an individual level.

### Observation Rubrics

Examples of rubrics have been provided on the next pages.

The intention of these rubrics is to help students reflect on what they have done well in relation to the learning goals, and what they could have done better. Students should mark an X to indicate their level of achievement (Bronze, Silver, Gold, or Platinum). You can also use the rubrics for your own evaluation of the students' work.

## Sample Rubric - Assessing Design Skills

	Bronze	Silver	Gold	Platinum	Notes
					
<p>Defining the problem:</p> <p>Describe the problem in your own words.</p>	The student is unable to describe the problem in their own words.	With prompting, the student is able to describe the problem in their own words.	The student is able to describe the problem in their own words.	The student is able to describe the problem in their own words and can begin to decompose the problem into smaller parts.	
<p>Designing solutions:</p> <p>Undertake a design project, engaging in the design cycle to construct and/or implement a solution that meets specific design criteria and constraints.</p> <p>Optimize performance of a design by prioritizing criteria, making trade-offs, testing, revising, and retesting.</p>	The student has difficulties completing a design project and engaging in the design cycle to construct and implement a solution.	The student has completed a design project, engaging in the design cycle to construct and implement a solution that met specific design criteria and constraints.	The student has completed a design project, engaging in the design cycle to construct and implement a solution that met specific design criteria and constraints. They have optimized the performance of a design using some of the following methods: prioritizing criteria, making trade-offs, testing, revising, and retesting.	The student showed creativity in using the engineering design process to implement a solution that exceeded specific design criteria and constraints. They optimized performance of their design using the following methods: prioritizing criteria, making trade-offs, testing, revising, and retesting.	

## 7. Integrate Formal Assessment during a lesson

### Stop at Line

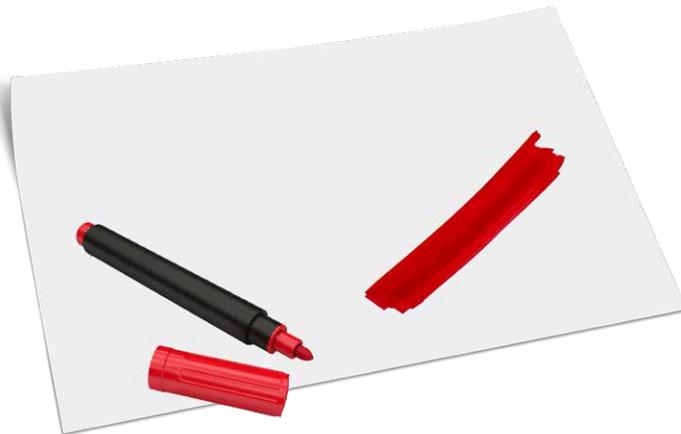
(45 minutes)

#### Objective

After completing this lesson, students will be able to use the Color Sensor to stop the robot when a line is detected

#### Setup

Define a starting position, then place a sheet of white paper with a colored line drawn on it a short distance away.



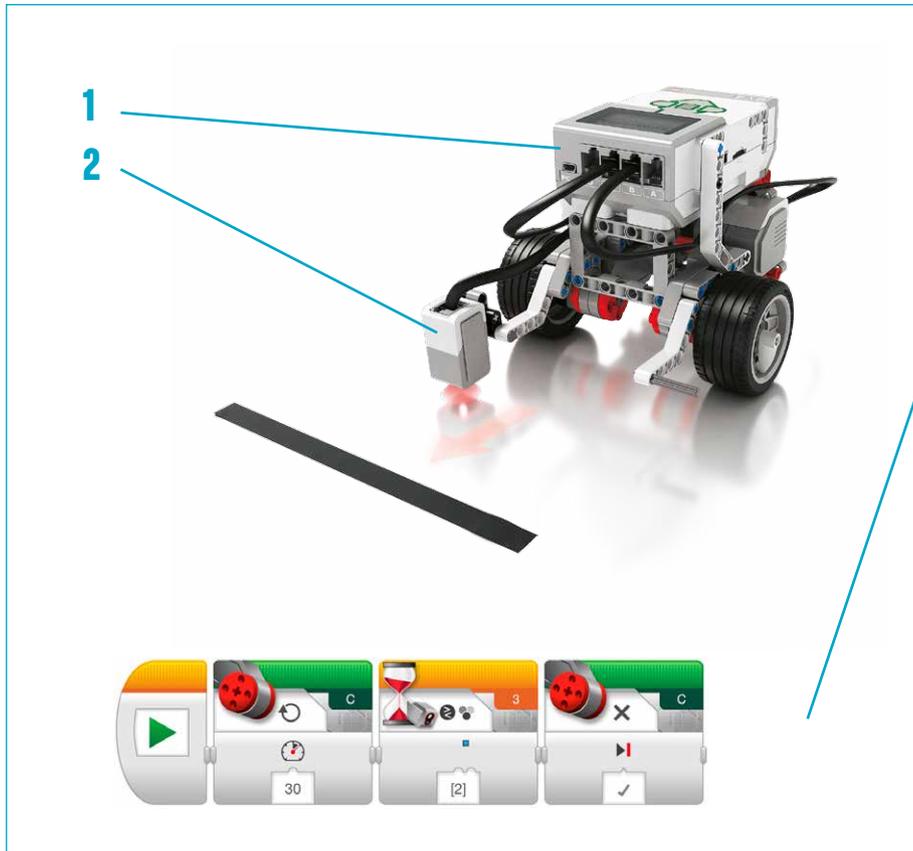
#### Assessment

During the lesson, encourage the students to interact with the rubrics. They should record their progress by marking the box that best reflects their level of achievement. Help your students to improve by providing frequent feedback.



### A. Connect

Objects will need to be dragged to specific locations identified by lines on the floor. Find ways to use the Color Sensor to detect these lines.



## B. Construct

### Build

1. Driving Base
2. Color Sensor Down Module

### Program

Try to have your robot stop at a black line.

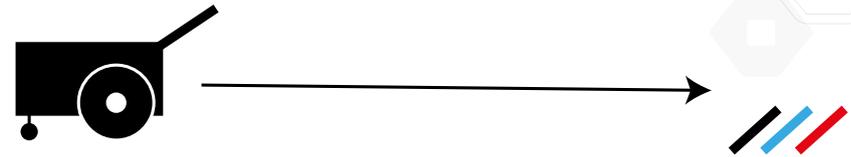
### Stop at Line



If you need help, look at the “Stop at Line” tutorial.

## C. Contemplate

- Have students practice detecting lines of different colors.



### Discussion Questions

#### Robot Behavior

Which color or shade reflects the most light? The least?

*White reflects the most and black reflects the least.*

#### Discovery

What would you do if the robot were to detect a line of the color gray?

*Use the Wait Block by setting it to read the Color Sensor in Reflected Light Intensity Mode.*

## D. Continue

Use the project ideas provided in this document or refer to some of our Curriculum Packs for additional ideas.

## 8. Use STEM Lessons in Your Classroom

### Develop STEM Skills with LEGO® MINDSTORMS® Education EV3

Using the Driving Base as the foundation, each of these four lessons offers a different STEM-related focus. Try one or try them all, each will guide you as you explore one of our Curriculum Packs.



**LESSON**  
**Coding Focus**  
page ..... **17**

#### Following a Line

Autonomous cars will soon be driving on our roads.

How do they follow their paths without deviating from the road?



**LESSON PLAN**  
**Science Focus**  
page ..... **18**

#### Measuring Speed

Biologists have long tried to calculate the running speed of animals.

Use a robot to find out how they do it!



**LESSON**  
**Engineering Focus**  
page ..... **19**

#### Fixing a Car

You are stranded in the forest because both front tires of your car have gone flat.

You have removed the wheels and must now use anything other than tires and rims to make your car move forward again.



**LESSON**  
**Math Focus**  
page ..... **20**

#### Moving in the XY Plane

To move an unmanned space vehicle from point A to point B requires precise calculations.

If the math is not right, you just might end up in the next crater!

## Coding Focus: Following a Line

(45 minutes)

### Curriculum Links

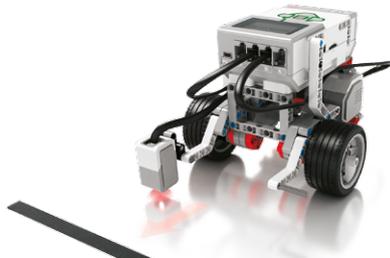
- Exploring the use of a loop
- Exploring ways of developing computational thinking skills, such as the ability to develop algorithms

### Connect

Autonomous cars will soon be driving on our roads. How do they follow their paths without deviating from the road?

### Construct

#### Build



#### Program

In the software, start with the “Switch” tutorial.

### Contemplate

Have the students create a driverless vehicle that can follow a line.

Ask them explore different types of lines, such as:

- Thick lines
- Thin lines
- Colored lines
- Right angles
- Broken/interrupted lines

### Continue

Create a racetrack in your classroom and find out whose car is the fastest.



For more coding activities related to autonomous cars, look online: [www.legoeducation.com/lessons](http://www.legoeducation.com/lessons)

## Science Focus: Measuring Speed

(45 minutes)

### Curriculum Links

- Exploring the concept of speed
- Exploring ways of developing science-related skills, such as the ability to collect and analyze data

### Connect

Biologists have long tried to calculate the running speed of animals. Use a robot to find out how they do it!

### Construct

#### Build



#### Program

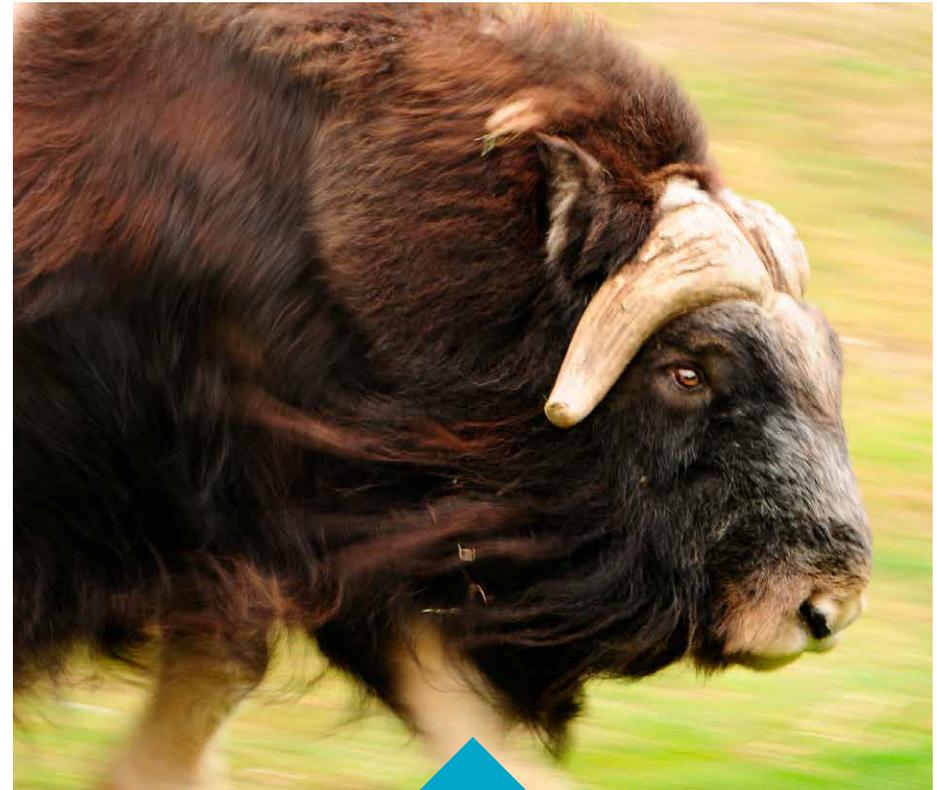
In the software, start with the “Math Data” tutorial.

### Contemplate

Use your Driving Base to model an animal “running” and calculate the speed at which it is moving. Change the speed of the motors to check that your calculations are correct.

### Continue

Create a racetrack in your classroom and find out whose car is the fastest.



For more science-related activities, download our science activity pack for EV3 Lab:  
[www.legoeducation.com/download](http://www.legoeducation.com/download)

## Engineering Focus: Fixing a Car

(45 minutes)

### Curriculum Links

- Exploring the concept of mechanisms
- Exploring ways of developing engineering-related skills, such as the ability to develop various functional prototypes

### Connect

You are stranded in the forest because both front tires of your car have gone flat. You have removed the wheels and must now use anything other than tires and rims to make your car move forward again.

### Construct

#### Build



#### Program

In the software, start with the “Straight Move” tutorial.

### Contemplate

Design a solution to make your Driving Base, now without its wheels, move as quickly as possible over a distance of one meter.

### Continue

Create a racetrack in your classroom and find out whose Driving Base is the fastest.



For more engineering-related projects, download our Design Engineering Projects Curriculum pack for EV3 Lab: [www.legoeducation.com/download](http://www.legoeducation.com/download)

## Math Focus: Moving in the XY Plane

(45 minutes)

### Curriculum Links

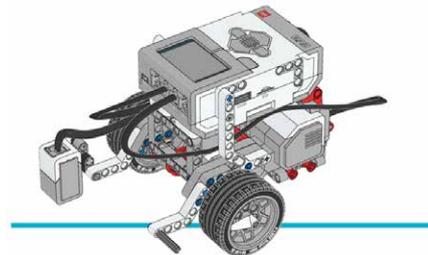
- Exploring the concept of position in the XY plane
- Exploring ways of developing math-related skills, such as the ability to make predictions and calculate results

### Connect

To move an unmanned space vehicle from point A to point B requires precise calculations. If the math is not right, you just might end up in the next crater!

### Construct

#### Build



#### Program

In the software, start with the “Variables” tutorial.

### Contemplate

Have students calculate the number wheel rotations necessary to move the robot forward 88 cm (35 inch) or a distance of your choice.

### Continue

Challenge the students by giving them one try to move their robots a specified distance. Whoever comes the closest wins!



For more space-themed activities, download our Space Mission Curriculum pack for EV3 Lab:  
[www.legoeducation.com/download](http://www.legoeducation.com/download)

## 9. Explore More Projects

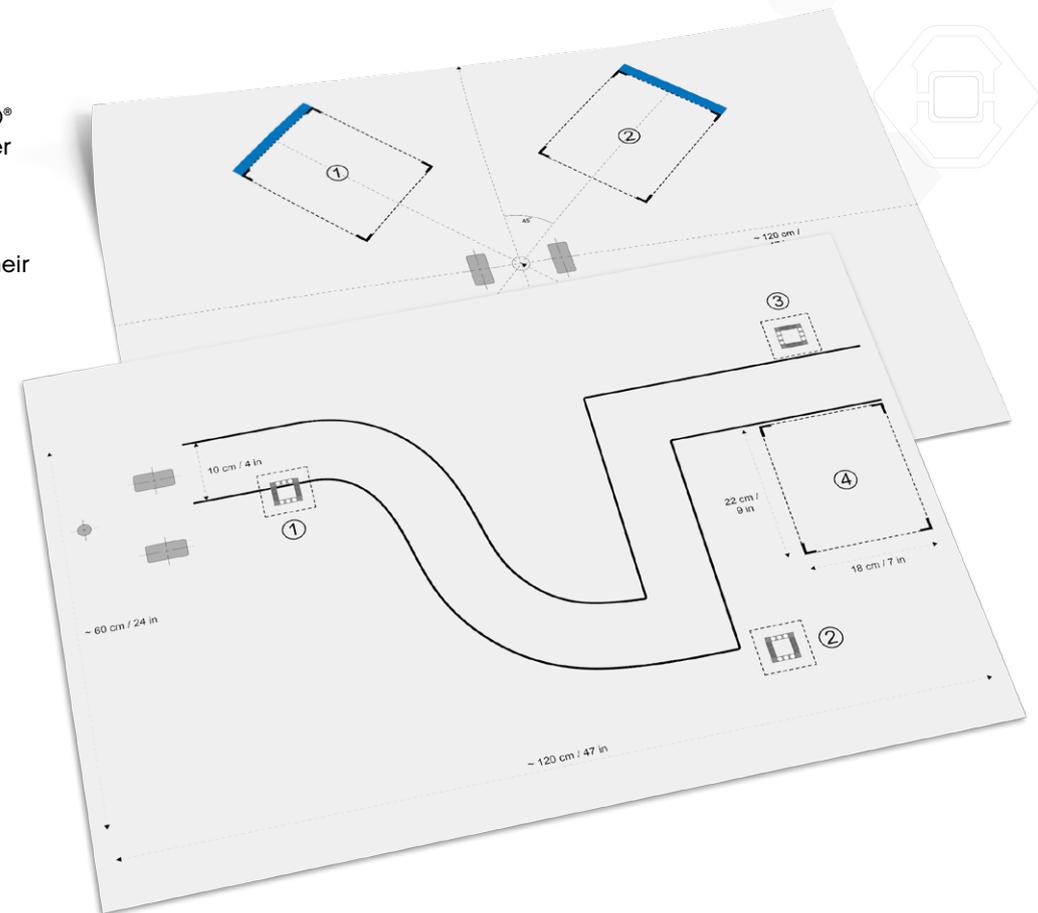
If you have reached this point, you might be looking for longer, more complex projects to use in your classroom.

Download new projects: [www.legoeducation.com/lessons](http://www.legoeducation.com/lessons)

## 10. Create a Playing Surface

The use of mats and other playing surfaces can come handy when doing LEGO<sup>®</sup> MINDSTORMS<sup>®</sup> EV3 projects. Surfaces can be made out of large sheets of paper using pencils and tape or they can be printed out.

Taking the time to set up a level playing table with smooth surface will increase your students' level of engagement and provide an "official" surface on which their robots can move.



## 11. Customize Your Lessons

### Use the Content Editor to Create Customized Tutorials (EV3 Lab Only)

The integrated Content Editor gives you the ability to customize any content in order to create your own differentiated lessons. Here are a few suggestions for customizing the tutorials:

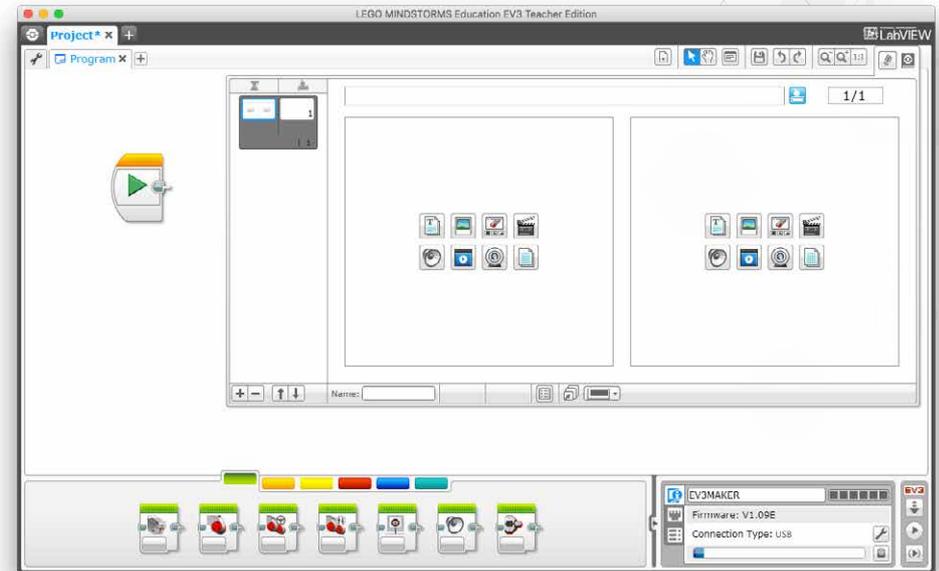
- Rephrase the text to better match your students' needs
- Add images that are more relevant to your students
- Add additional tasks

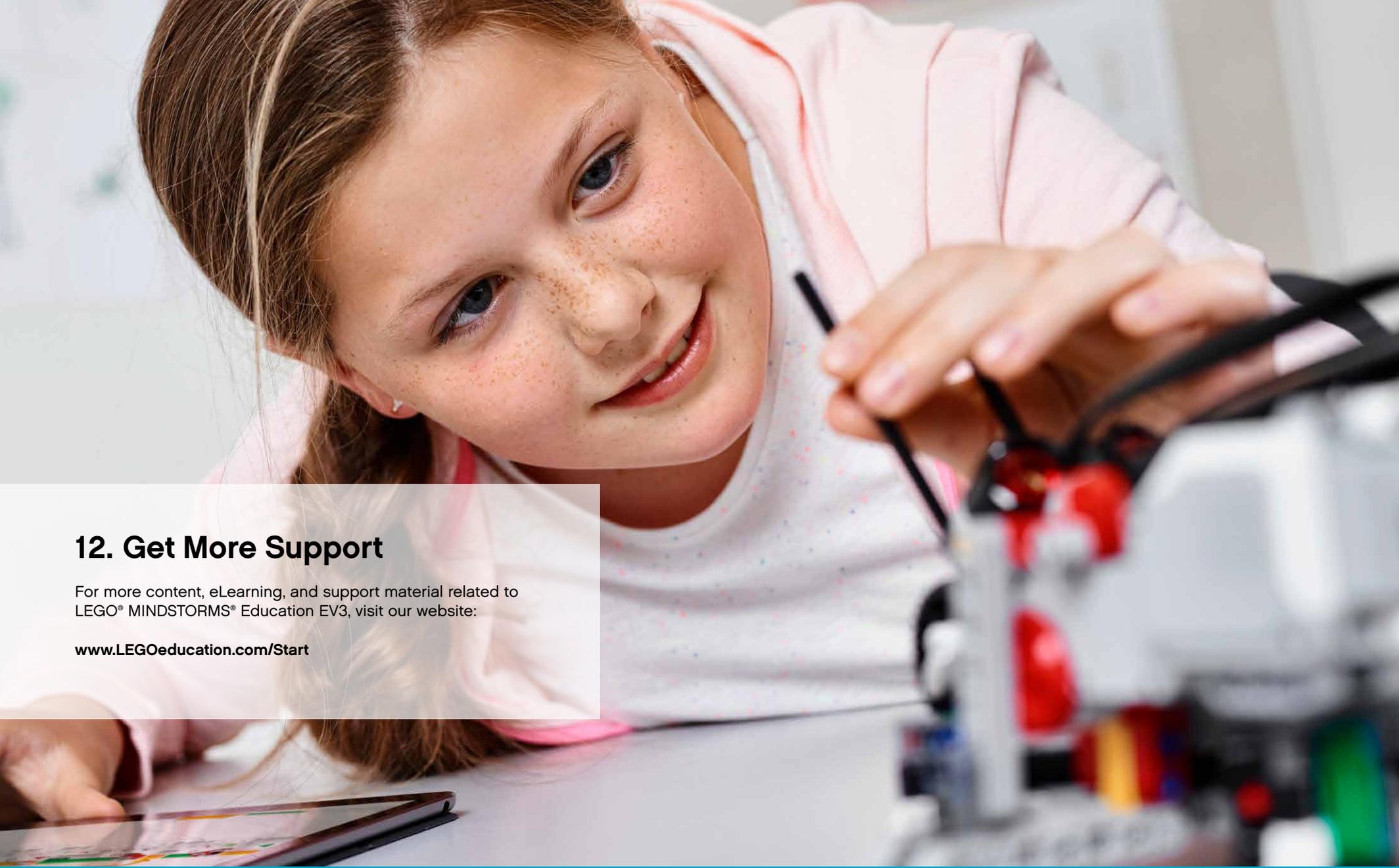
To ensure that you do not overwrite the tutorials supplied with the LEGO® MINDSTORMS® Education EV3 Lab, any changes you make will be saved as a new tutorial. All of the files included with the original tutorial will also be included in the new project file, which you are then free to share with your students (e.g., on a shared network drive).

### Additional Materials

Customize your lessons using materials you already have in your classroom, such as:

- Large sheets of paper
- Colored tape or paper (minimum suggestion: black, blue, gray, and one other color)
- Objects of different shapes and sizes
- Protractors
- Measuring tapes
- Markers





## 12. Get More Support

For more content, eLearning, and support material related to LEGO® MINDSTORMS® Education EV3, visit our website:

[www.LEGOeducation.com/Start](http://www.LEGOeducation.com/Start)

[LEGOeducation.com/MINDSTORMS](http://LEGOeducation.com/MINDSTORMS)

 **mindstorms**  
education **EV3**

## CHECKLIST

- Software is installed
- Software has been opened once to check that it loads properly
- LEGO® Bricks have been sorted
- Box and electronic components have been labeled
- The EV3 rechargable battery has been inserted in the EV3 Brick and charge (or the EV3 Brick has AA batteries)
- EV3 Brick has been renamed

**Let's Prepare**

- I know how to drag icons to the Programming Canvas.
- I know how to change the parameters on a programming block.
- I can turn a motor on and off.
- I can use the Touch Sensor.
- I can use the Color Sensor.
- I can use the Ultrasound Sensor.
- I can turn the EV3 Brick on and off.
- I know the difference between an output port and an input port on the EV3 Brick.

**Let's Try**

Find more support online:

[www.legoeducation.com/support](http://www.legoeducation.com/support)

