Robotics

Robotics combines engineering and programming to create machines that are capable of performing tasks autonomously. Our robotics curriculum includes lessons plans, worksheets, and custom-designed games to teach foundational programming and problem solving skills with LEGO Mindstorms EV3.

Lessons

- build and prep
- move block
- move block computer
- design thinking

Download lesson plans

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Workbook

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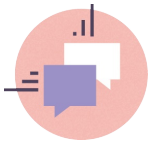
Build and Prep

Robotics



OVERVIEW

Students learn about robotics through watching videos and group discussion. For this lesson, stduents build the EV3 educator model using their Lego Mindstorm kits.

OBJECTIVES

Students will be able to:

- Describe what it means to be a robotics engineer
- List three possible uses for robots

AGENDA

Length: 45 minutes

1. Introduction to robots
2. Introduction to EV3
3. Build

MATERIALS

- Sensors handout
- EV3 Educator Model Building Instructions

INTRODUCTION TO ROBOTS

Length: 10 minutes

Students learn about the robotics field and explore cool things robots can do.

Prep:

Teacher Actions	Student Actions
1 Introduce Tech and Tape: Tech and Tape is a collaboration between 9 Dots and DIY Girls – two Los Angeles-based nonprofits dedicated to providing students with a fun tech education. The goal for this class is to create Sumo bots that will wrestle each other in a tournament. To create the Sumo bots we are going to have to learn about robotics!	
2 Watch Darpa robotics challenge	
3 Discuss Which do you think was the coolest robot? Why?	3 Students raise their hands to offer answers.

4 Watch A day in the life of a robotic engineer video	
5 Discuss What do you think it means to be a robotic engineer? What are some ways that you think robots are used currently?	5 Students raise their hands to offer answers.
6 Talk about modern uses for robots: • Surgery • Factories • Search and rescue • Cleaning • Bomb disposal • Exploration (space, sea)	

INTRODUCTION TO EV3

Length: 5 minutes

Students learn specifics about how hte Mindstorm EV3 robots work.

Prep:

Teacher Actions	Student Actions
1 Distribute the Mindstorm sensors handout. • Discuss with students what they think the sensor can be used for	1 Students fill in the handout with ideas about what each sensor does and how it can be used for Sumo.
2 Explain the sensors: • Motor - for driving the robot. Also a strong building piece • Touch sensor - for detecting when the robot has touched an object • Ultrasonic sensor - for measuring distance • Color sensor - for checking colors	2 Students take notes on their paper to clarify what the sensors are used for.
3	

	Show students the building plans for the EV3 Educator Model. Explain that this robot is helpful for learning how to program the robot, and that students will be coming up with their own designs later in the unit.	
4	Discuss Why is it important to organize Lego pieces properly? • Future building can be more efficient and more fun if it is not necessary to hunt for every little piece.	4 Students raise their hands to offer answers.

BUILD

Length: 30 minutes

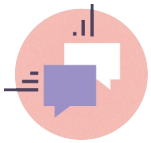
Student build their robots using the LEGO EV3 Educator Model instructions

Prep:

Teacher Actions	Student Actions
1 Tell students that the first step is to organize their building materials.	1 Students organize their lego box according to the diagram provided with the boxes.
2 Tell students they have the rest of the class to build their robots according to the instructions. Emphasize the importance of using the correct Lego pieces for each step. Rushing and using the wrong ones will lead to robots that do not function properly.	2 Students should now begin building using the plans.

Move block

robotics



OVERVIEW

This lesson serves as an introduction to programming using the EV3 software (this is useable with the older NXT bricks as well). Students have their first programming challenge to guide their teacher through a maze using programming instructions.

OBJECTIVES

- Students will decompose a problem
- Students will be able to use decomposed elements to solve a problem

AGENDA

Length: 45 minutes

1. Explore
2. Programming
3. Building

VOCAB

- decompose - the act of developing a problem story, identify the requirements to solve the problem, and form a plan to connect the required components.
- sequence - the order in which the coding elements are executed

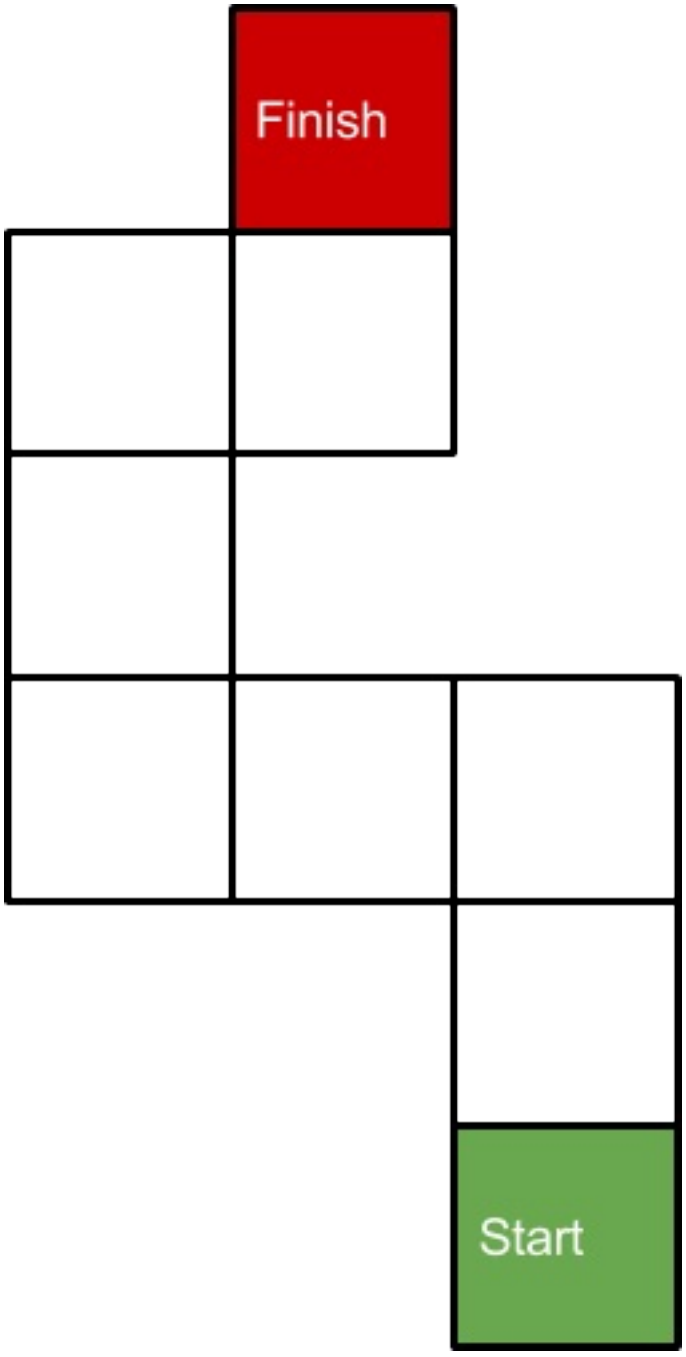
MATERIALS

- Lego Mindstorm Kit
- Completed Mindstorm Robot (from lesson 1)
- Computer with EV3 Software
- Programming Instruction Video
- Teacher-created Maze with Duct Tape (2 colors)
- Move block cut outs

Lesson Prep:

- Print and cut Move block cut outs
- Make a teacher maze using tape on the floor.

  Example:


Finish
Start

EXPLORE

Length: 10 minutes

Introduce the idea of being a programmer to students by watching videos and having a group discussion.

Prep:

- Set up projector
- Cue up videos

Teacher Actions	Student Actions
1 Start a discussion with students by asking, "What do programmers do?" Programmers give detailed instructions to computers to solve problems and accomplish tasks.	1 Students raise their hands to provide answers.
2 Watch: A Day in the Life of a Software Engineer: https://www.youtube.com/watch?v=vt79JcPfZQA	2 Students watch the video.
3 Why is it important to have a diverse group of people creating software for the world?	3 Students raise their hands to provide answers.
4 Watch: A Day in the Life of a Roboticist: https://www.youtube.com/watch?v=90Z3cFzV_j4	4 Students watch the video.
5 How does learning how to code play a role in making robots?	5 Students raise their hands to provide answers.

PROGRAMMING

Length: 25 minutes

Introduce programming with an exercise on paper called teacher robot.

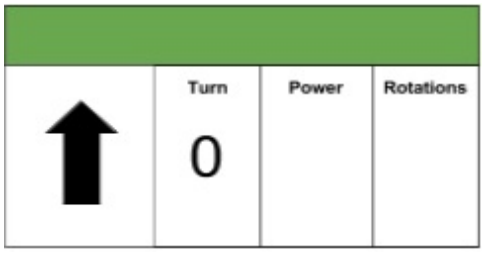
Teacher Actions	Student Actions
1 Show students the maze and explain the first step to solving a problem is to decompose the problem. Decomposition consists of developing a problem story, identify the requirements to solve the problem, and form a plan to connect the required components.	
2 Ask the students to come up with a story to explain what the problem is that they are facing.	2 Students develop a problem story
3 Guided discussion Target: "The robot needs to get from the start zone to the finish zone."	

4 Ask students to turn to a person sitting next to them and discuss the requirements (what the robot needs to be able to do) for achieving their goal.	4 Students discuss with their partner the requirements to achieve the goal.
5 Guided discussion Target: • Move forward • Turn right • Turn left	
6 What do those three requirement have in common? Is it possible to describe them all as moving the wheels of the robot? • What is the difference between the movements? • What do you need to be able to change about the movement to allow for turning and covering different distances?	
7 Guided discussion Target: • Rotation (distance) • Turn (angle)	

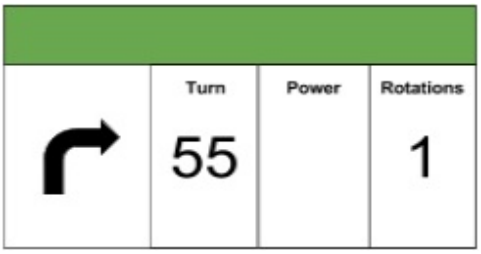
8 Give each student a set of the move block cutouts. The move block can control:

- steering - turning direction (already filled in)
- power - how fast the robot moves
- rotations - how far to move

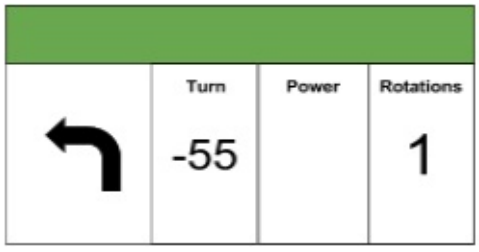
9 As a group discuss what each of the three different move blocks mean.



move forward



turn right 90 degrees



turn left 90 degrees

10 Tell students to create a sequence (from left to right) of blocks to program the teacher robot to solve the maze. The teacher robot performs the student instructions. If there are bugs, return the paper to the student. How to be teacher robot: • Forward: Walk forward one box for each rotation • Turn left: turn 90 degrees left (this does not move you to a new space) • Turn right: turn 90 degrees right (this does not move you to a new space) `Make sure to follow student ins tructions exactly as they are w ritten!`	**10** Students develop and create a list of commands using their move block cutouts. When they are done, the teacher reads and enacts their list of instructions.

BUILDING

Length: 10 minutes

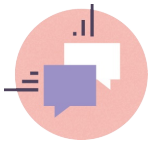
Introduce students to building attachments.

Teacher Actions	Student Actions
1 Show students the maze again and explain that their robot has to push a lego through the maze. To accomplish this, students need to build an attachment. `An attachment is an additional piece that can be added onto a robot to help it achieve new go als.`	
2 Give students 2 minutes to brainstorm problems their current robot might have while trying to push a lego.	2 With a partner, students brainstorm problems that the robot might run into while trying to push a block.
3 Guided Discussion Target: • Lego gets stuck under robot • Lego slides off to the side	3 Students offer answers by raising their hands.

• Lego blocks wheels	
4 Think To develop a solution, students start by sketching 3 ideas on a piece of paper.	4 Each student sketches 3 ideas for their attachment.
5 Pair Put students in groups of 2	5 Students sit with a partner.
6 Share Tell students to share their sketches and explain how each design deals with the problems the class discovered.	6 Students share their sketches and explain how each design deals with the problems the class discovered.

Move block online

Robotics



OVERVIEW

Students continue learning about simple and complex behaviors by programming their Mindstorm robots. Start by teaching how to program in the EV3 environment and download programs to the robot for testing. Students demonstrate learning by giving their robots commands to navigate a maze.

OBJECTIVES

1. Students will be able to create a sequence on the computer.
2. Students will be able to use the move block.

AGENDA

Length 45 minutes

1. Explore - Watch a video of a robot and discuss the importance of building in robotics.
2. Explain - Show students how to program the robot in the EV3 software.
3. Engage - Students program their robots to solve the maze.

VOCAB

MATERIALS

1. Finished robot
2. Hand written program and lego attachment from move block lesson
3. Computer with EV3 Software
4. Move Steering Handout
5. Teacher-created Maze
6. Iteration Log

EXPLORE

Length: 10 minutes

Watch a video of a good lego robot and discuss the importance of building.

Teacher Actions	Student Actions
1 Show the video of the world champion robot from 2013-14 First Lego League challenge as an example of a very well designed and programmed EV3 robot.	1 Students watch the video.
2 Discuss with students the importance of combining good engineering and good programming.	2 Students raise their hands to offer answers.

EXPLAIN

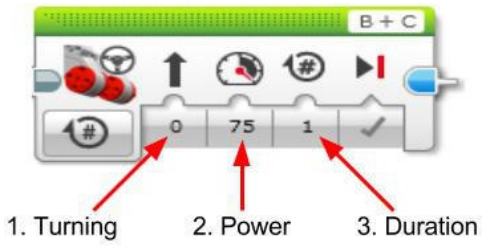
Length: 15 minutes

Show students how to program the robot in the EV3 software.

Prep:

Teacher Actions	Student Actions
1 Distribute the Move Steering handout and show students the maze that the robot has to navigate.	
2 What do you think the blanks on the handout are used for when programming the robot?	
3 Guided Discussion • Turning: Positive numbers turn right, Negative numbers turn left, and 0 means straight. • Power: How fast the motor spins. 0 is the slowest; 100 is the fastest. • Duration: How long the motor turns on for in rotations. 1 rotation is one	3 Students fill in the 3 parts of the Move Steering block on their handout: • Turning: Positive numbers turn right, Negative numbers turn left, and 0 means straight. • Power: How fast the motor spins. 0 is the slowest; 100 is the fastest.

full spin of the motor.



- Duration: How long the motor turns on for in rotations. 1 rotation is one full spin of the motor.

4 To create a sequence, connect multiple blocks together from left to right Give students time to complete the rest of the handout.

5 Show students the EV3 software and demonstrate where to find the Move steering block

5 On the handout, students describe the behaviors for each move steering block. The finished answer should look like this:

6 Show students the iteration log and ask students about why it is important to identify where in their code a bug occurred.

7 Show students the iteration log and ask students about why it is important to identify where in

their code a bug occurred.	

ENGAGE

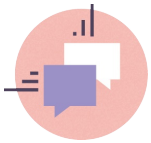
Length: 20 minutes

Students program their robots to solve the maze.

Teacher Actions	Student Actions
1 Tell students to get a computer, open the Mindstorm EV3 software, and create a new program.	1 Students get a computer, open the Mindstorm EV3 software, and create a new program.
2 Ask students what they notice about all of the turns on the maze? What parts of the move block do they need to it to change how much the robot turns?	
3 Guided discussion Target: • All of the turns are 90 degrees • Students will need to adjust turn and rotation to successfully complete a turn.	3 Students raise their hands to give answers.

4 Tell students that their first goal is to edit a move block on their computer to complete a 90 degree turn.	4 Students can now begin programming their robot to complete a 90 degree turn.
5 Student create a program to solve the maze. The goal is to create the robot that finishes the maze the quickest.	5 Students begin programming their robot to complete the maze from previous lesson. • Students should use their program (the written down instructions) from the 'teacher robot' activity to help organizing the behaviors for the actual maze challenge. • Students keep a log of where each attempt could be improved using their iteration log handout.

Design thinking
Robotics



OVERVIEW

Students will be able to use the design thinking method to creatively design their sumo robots.

OBJECTIVES

1. Students will be able to list the steps of the design thinking process.
2. Students will be able to apply the concepts of design thinking.

AGENDA

Length: 90 minutes

1. Explain - Students see the sumo ring and start to think about how to build in terms of defense, offense, and simple attachments.
2. Engage - Students learn about design thinking, then prototype and test their attachments in a sumo battle.

VOCAB

- Design thinking process - An iterative process that cycles through developing ideas, creating prototypes, and testing solutions.

MATERIALS

1. Design thinking handout
2. Mindstorm robot kits
3. Lego EV3 software

EXPLAIN

Length: 10 minutes

Students see the sumo ring and start to think about how to build in terms of defense, offense, and simple attachments.

Teacher Actions	Student Actions
1 Show students the Sumo ring. Explain that the goal of the game is for one robot to push the other one outside of the ring.	
2 Guided discussion - Now that students have learned how to program a robot, what is another important part to robotics? Target: Developing a good design is very important for robotics.	2 Students raise their hands to provide answers.
3 Explain that before building, students will go through the design thinking process to think creatively and systematically about building the best robot.	

4 The three most important aspects students should consider are: defense, offense, and simple attachments.

- defense - your robot should be able to defend itself from attacking robots
- offense - effectively knock over, wedge, or push opponent off sumo mat
- simple attachments - clip attachments on and off in less than 3 minutes.

ENGAGE

Length: 35 minutes

Students learn about design thinking, then prototype and test their attachments in a sumo battle.

Teacher Actions	Student Actions
1 Distribute the design thinking worksheet.	1 Students fill in the blanks on the first page of the worksheet as the steps are explained.
2 Start by explaining the steps to the design thinking process: • Empathize: Understand the way your users do things and why, their physical and emotional needs, how they think about world, and what is meaningful to them. • Define: Define the challenge you are taking on, based on what you have learned about your users and about the context. • Ideate: You ideate in order to move from identifying problems to creating solutions for your users. Ideation is your chance to combine the understanding	

you have of the problem and people you are designing for with your imagination to create ideas for solutions. • Prototype: Build samples of your ideas that can be tested. Don't get too attached to any one design. • Test: Put your prototypes to the test. Take notes on what works and what needs to change in the next iteration.	
3 Demo a sumo battle using two robots that have no attachments. The robots should start facing each other and be running a simple program that moves straight forward.	3 Students watch the battle and take notes on their handout.
4 Tell students to work on the first three sections of the handout by themselves.	4 Students fill in the empathize, define, and ideate sections of their handout individually.
5 Share - Split students into groups of two. Each student will explain and justify their ideas with a partner.	5 Students explain and justify their ideas with a partner.
6	6

Tell students that collaboration (working together) is an important part of creating a good product. With their partner, students will create a new sketch that uses the best pieces from each participant.	With their partner, students sketch an idea for their attachment that incorporates the best ideas from each partner.
7 Ask students what happens after ideate. What do students think is the most important part of that process?	7 Still in groups, students build their first prototype.
8 Guided discussion Target: • Prototype comes after ideate • When prototyping, it is important for the students to build quickly instead of working on a perfect version. The idea will have to be fixed many times before the final product is ready.	8 Students raise their hands with suggestions. After the discussion, students start to build their prototypes with their group.
9 Students begin prototyping their design. Whenever two groups are ready, they should test their robots by doing a Sumo battle with them. For today, the robots will always be aimed directly at	9 Students battle their robots, and then fill out the test section of their handout.

	each other and should move in a straight line towards the other robot.	
10	After the test, students either improve their current design or go back and build another prototype from their ideas.	

If a group is satisfied with their front attachments, have their robot start faced away from their opponent. Tell students that their robot needs have good defense on all sides!