Robotics at Works

LEGO® MINDSTORMS® Education EV3
Introductory Robotics Program

Robotics at Work
LEGO® MINDSTORMS® Education EV3 Robotics Program

Middle School Robotics Overview:
This 4-day robotics program outline will provide students with STEM focused hands-on activities to promote 21st century skills as well as design engineering and computer science. Each day, students will participate in team building activities and opportunities for physical activity as well as receive a daily team briefing for daily challenges aligned to standards. Daily challenges will help students develop skills and knowledge to complete the culminating project of designing a solution for a problem in a career area and pitching the solution to stakeholders.

Program at a Glance		
Day 1	**Welcome to Orientation** Why do we use robots? What can a robot do that humans cannot?	• Exploring Robots • The Inner Workings of a Robot: Gearing Challenge
Day 2	**Orientation Day 2** **Exploration** Why do we explore? What tools do scientist use to explore?	• Build a Robot Move With and Without wheels
Day 3	**Robots at Work: Make it Turn** How do robots use a sensor that detects an object?	• Stop at an Object • Turn, Turn, Turn
Day 4	**Robots at Work: Make it Smarter** How can sensors make a robot smarter?	• Turn using a Gyro Sensor • Detect a Color • Stop at a Line
Day 5	**Design Challenge: Maze** Culminating Project	• Wrap Up Culminating Project • Showcase

Prior to First Day:

1. Sort the sets.
2. Charge the EV3 Batteries.
3. Download and install the EV3 software on devices to be used for the program.
4. Determine a naming convention for each set.
   Suggestions include school initials and a number (Example: Millcreek Elementary robotics set names could be MES1; MES2; MES3). Write the name on the EV3 brick and on the set.
5. Connect the EV3 to an iPad, Chromebook or computer and rename each brick on the computer to match the name you assigned to the set.
6. Gather any consumable materials needed for the week.
7. Make sure devices that will be used are fully charged, Bluetooth is enabled (if needed) and students can access the software.
8. Determine a procedure for when a LEGO piece is dropped (everyone freeze; say LEGO down/LEGO found) and where to place LEGO pieces that do not belong to the finder.
9. While teams are working, assign each group an EV3 set to use for the week.

Robotics at Work Day 1
Orientation

Big Questions:

- Why do we use robots?
- What can a robot do that humans cannot?

Materials:

- EV3 sets
- Devices with EV3 software
- Chart paper
- Student journals (could be paper stapled together with students creating the outside of the journal using construction paper and other consumable materials)
- Various craft materials
- Pens
- Pencils
- Markers

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Introductions	30 min	• LEGO bricks
	Establishing Group Rules and Expectations	15 min	• Chart paper • Markers • Pens
	Team Building Activity	15 min	• LEGO bricks
	Team Briefing	5 min	• None
	Partner Selection, Team Name and Team Badge	25 min	• Varies, based on the activity selected • Team badge templates • Markers • Pencils • Scissors
10:30 - 10:35	Break		
10:35 - 11:25	Workplace Wellness	10 min	• Varies, based on the activity selected
	Design a Journal	20 min	• Student journals • Markers

			• Scissors • Construction paper • Other craft materials
	Reading and Wondering	20 min	• Book about robots • Student journals
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Team Briefing 2	5 min	• None
	Challenge 1: Exploring Robotics	30 min	• Student journals • EV3 set • Devices with software
	Challenge 2: The Inner Workings of a Robot: Gearing Challenge	75 min	• Student journals • EV3 set • Devices with software
	Break	5 min	• None
	Disassemble Models and Inventory Sets	15 min	• EV3 set
2:10 - 2:30	Daily Debrief and Wrap Up	20 min	• Student journals

Introductions
Time: 30 minutes
Materials:

- Loose LEGO bricks

Using the LEGO bricks, have students build a model that shows something they really like to do and one thing they really hope to learn at this robotics program. When it is time to share, have students say their names and share their models. The teacher can record what the group hopes to learn on a piece of chart paper.

Group Rules and Expectations
Time: 15 minutes
Materials:

- Chart paper
- Markers

Using a piece of chart paper, establish group rules and expectations for the week as a class. You can have students sign the chart paper and then place the rules and expectations in a location that can be reviewed each day.

Team Building Activity
Time: 15 minutes
Materials:

- Loose bricks

Explain to students that each day will include some kind of team building challenge. Working together is an important skill and just like other skills, we can practice it to get better and better.

Build the tallest tower

Have students work in pairs. Make sure each group has the same bricks or give a constraint of using a specific number of bricks. Challenge students to build the tallest tower they can within 5 minutes. At the end of the 5 minutes, encourage students to reflect on:

- What was challenging?
- How did you overcome the challenge?
- What was successful?
- How did you work together?
- If you were to do this tower build again, what would you change?

Team Briefing 1:
Time: 5 minutes
Materials: None

Welcome to orientation! Your first tasks for today are as follows:

- *Determine a partner for training exercises.*
- *Work with partner to determine a name for your design company and a logo.*
- *Design a journal for keeping important records this week.*
- *Explore different ways we use robots.*

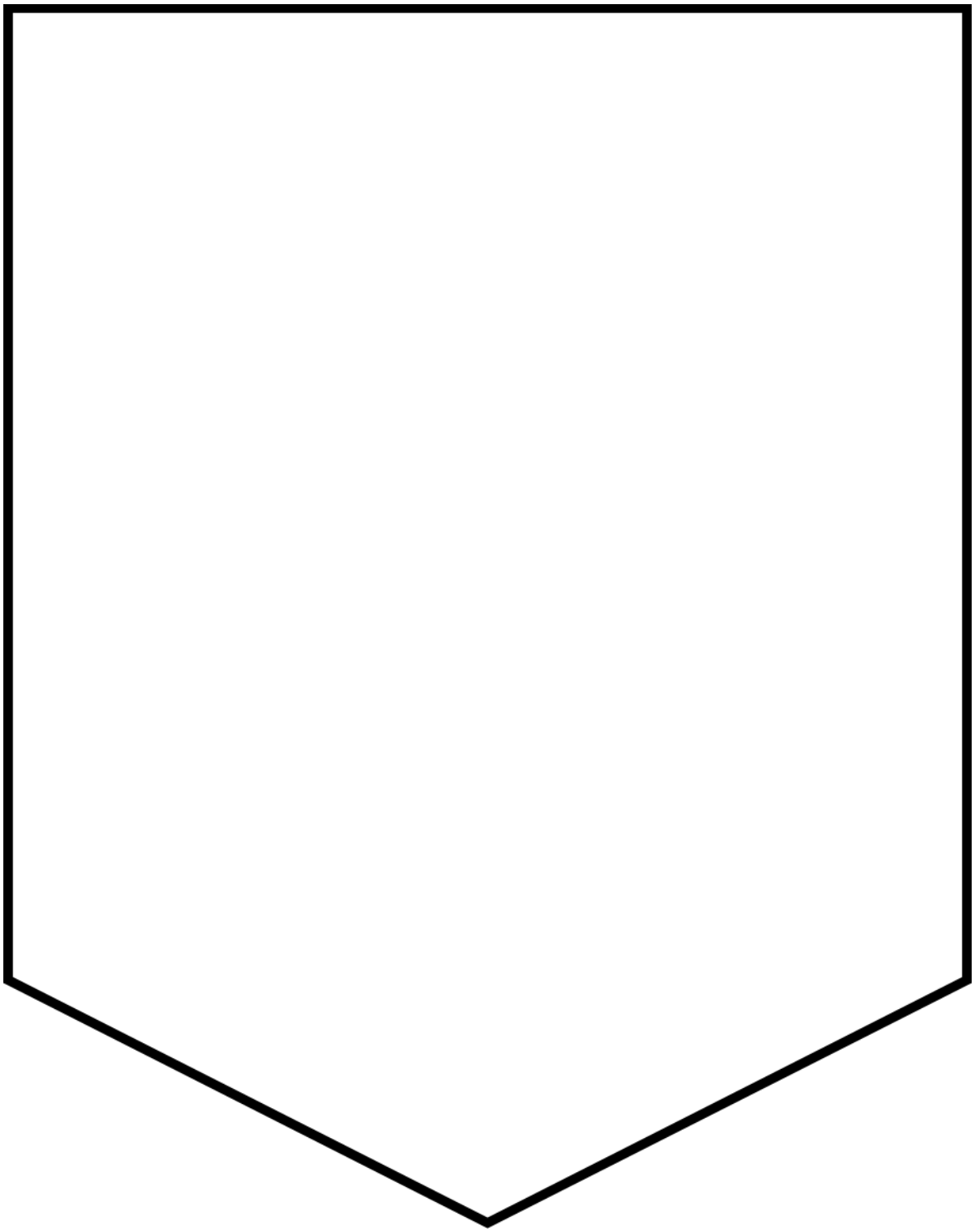
Partner selection, design company name and logo
Time: 25 minutes
Materials:

- Student journals (see note in materials section)
- Markers
- Scissors
- Construction paper
- Other craft materials

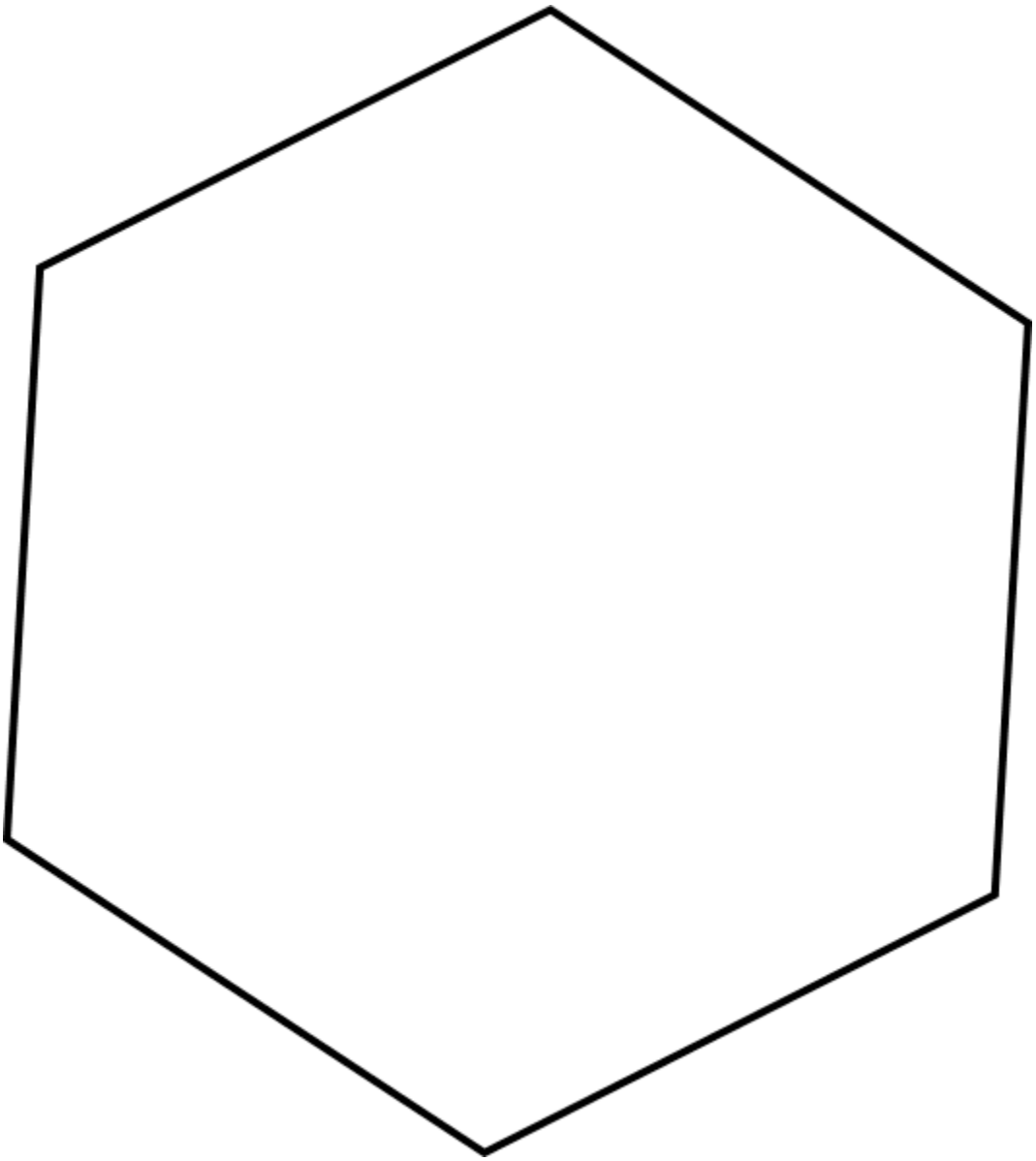
You can find suggestions for grouping or pairing students from various web resources. A simple web search for creative ways to group students may provide appropriate resources for you to review.

Once partners have been established, student teams can determine a design company name (team name) for their team and design a logo.

LOGO Template



LOGO Template



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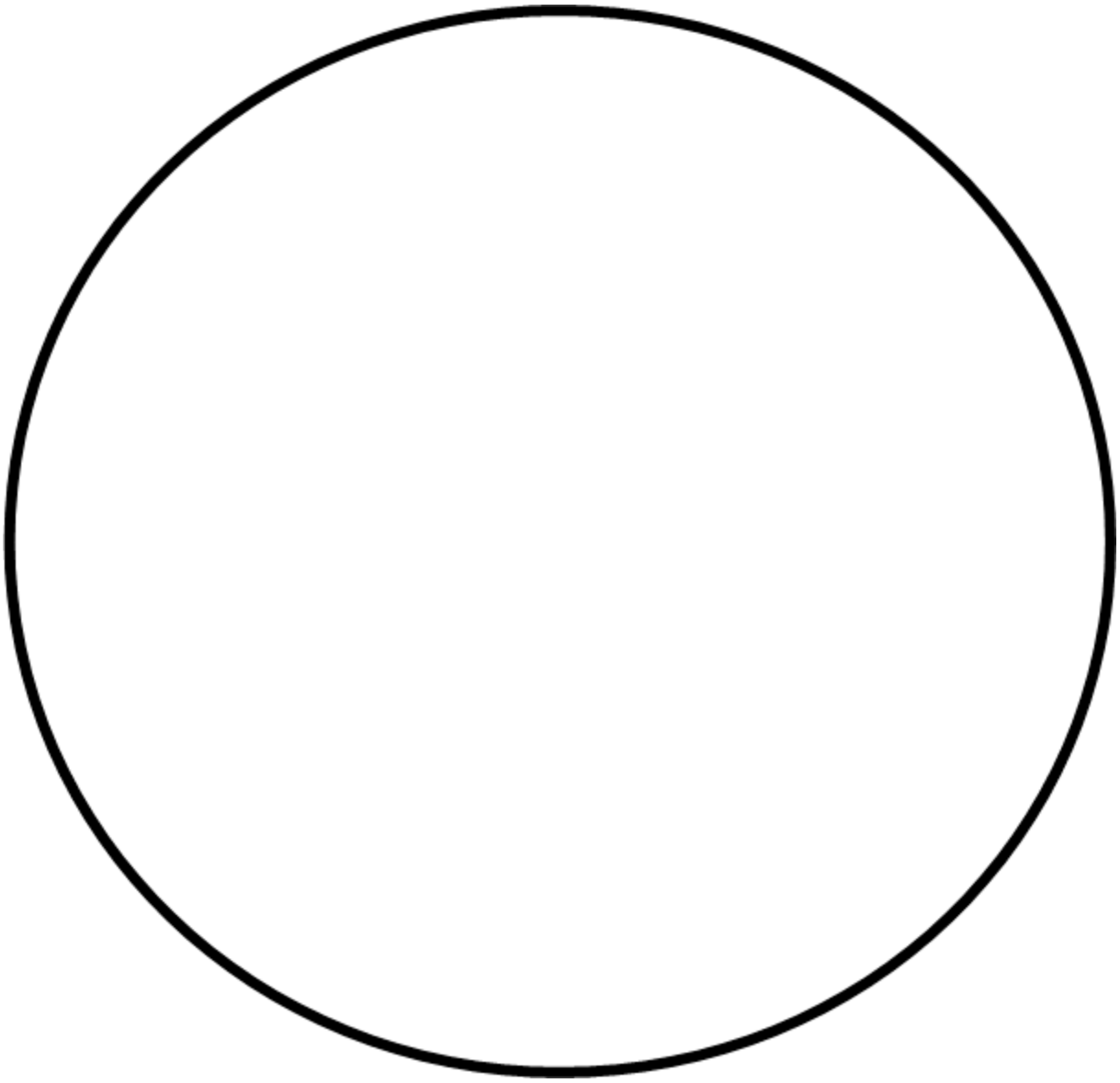

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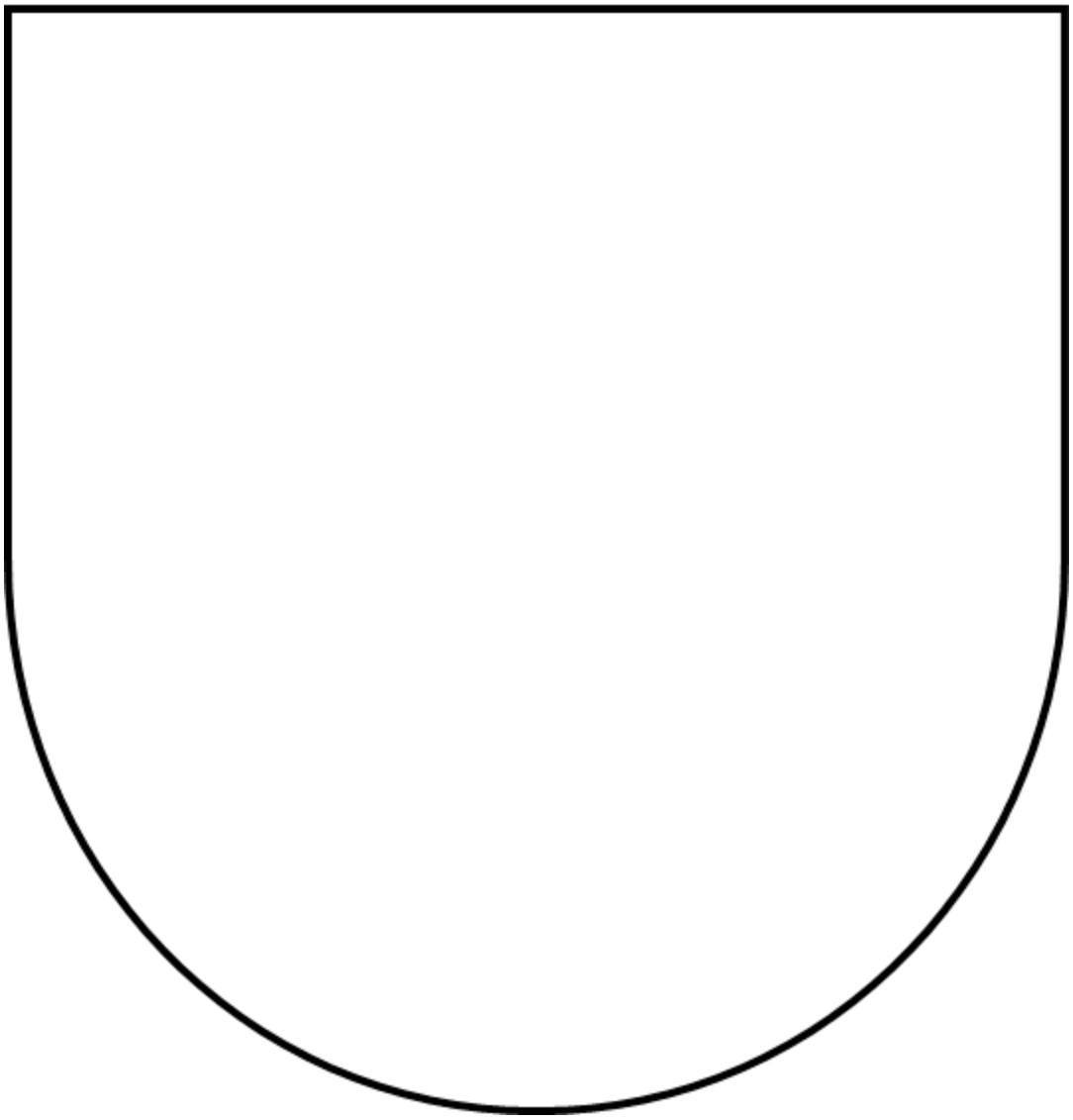

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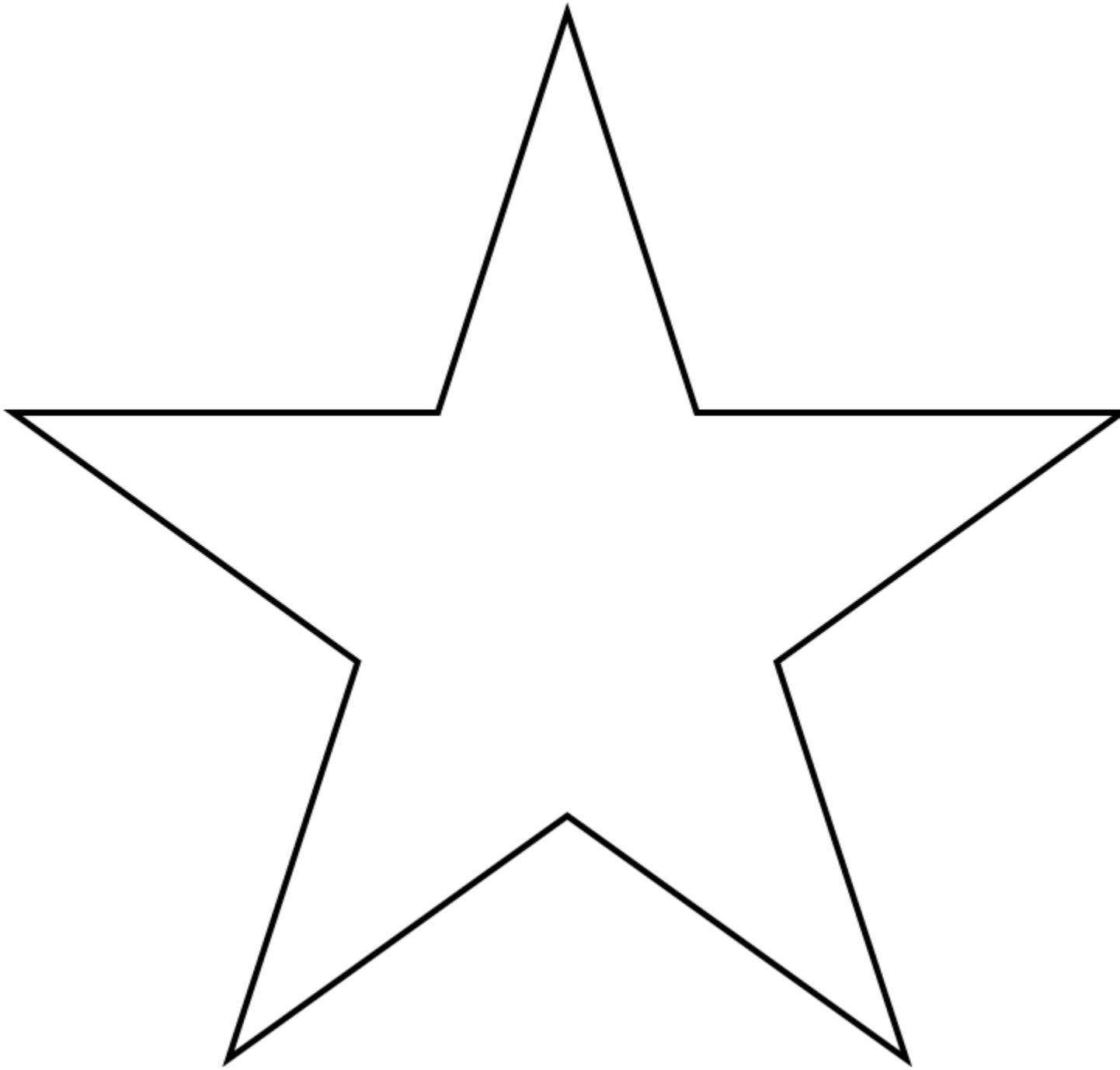


Break
Time: 5 minutes

Workplace Wellness
Time: 10 minutes
Materials:

- Vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Manufacturing companies often encourage physical activity during the workday.

Design a Journal
Time: 20 minutes
Materials:

- Student journals (see note in materials section)
- Markers
- Scissors
- Construction paper
- Other craft materials

Have students create a journal to take notes, share wonderings, write reflections, and collect ideas. Ideas for types of journals can be found online.

Readings and Wonderings
Time: 20 minutes
Materials:

- Book or articles about robots

Read a book or a kid friendly journal article about robots and what robots can do that humans cannot. Have students write things they wonder about robots in their journals.

Lunch
Time: 30 minutes

Team Briefing 2:
Time: 5 minutes
Materials: None

Now that you have your team and have some background information about how robots, you now have a new challenge. To be better prepared for the days ahead, you will need some basic training on the tools we will use this week. You mission this afternoon is to:

- *Explore how robots use motors and sensors to move and make decisions.*
- *Learn how to program utilize a robot through using programming blocks.*

Be sure to work together, take good notes and have fun!

Go over a few general guidelines for using the EV3 sets.

- What do you do if you drop a piece on the floor?
- Where do you put a piece you have found?
- What does sharing look like?

Challenge 1 – Exploring Robotics (large motor and use a touch sensor)
Time: 30 minutes
Materials:

- EV3 Sets
- Device with software
- Student journals

Students will:

- Connect a motor and sensor to the hub/smart brick
- Connect the model and device
- Program the hub/smart brick to make the motor run and to make the motor run using a sensor.

Ask students:
Why do scientists use robots?
Lead a discussion on how robots can do things that humans cannot.
Scientists use robots to go places that people cannot in order to learn about these places. The Mars Exploration Rovers have allowed us to learn about Mars without traveling there.

Prior to the lesson, you may choose to locate videos of images of the Mars Rover from NASA to share with students.

Part 1
Have students complete the Getting Started Lesson — Large Motor by connecting a large motor to the hub/smart brick and exploring ways to program the motor to move. Students can add an axle or other bricks to the motor to explore how connected items will move with the motor. Students should take notes in their journals.
They should be able to answer questions like:

- How does the motor move?
- Which programming blocks can control the motor?
- How can you change the movements of the motors?
- How does connecting other elements to the motor make them move?

Part 2
Have students complete the Getting Started Lesson — Use a Touch Sensor by connecting the touch sensor to the hub/smart brick (leave the motor attached). Students should explore how to program a sensor and understand how sensors can be used to control motor movement. Students should take notes in their journals.
They should be able to answer questions like:

- How does a sensor work to control the actions of a robot?

- How do you use the programming blocks to control the sensor?

Take the elements apart.
Have students reflect in their journals:
- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Challenge 2: The Inner Workings of a Robot: Gearing Challenge
Time: 75 minutes
Materials:
- EV3 Sets
- Device with software
- Student journals

Gears are an important element in designing an action for your robot to carry out because they allow for movement. Let's explore how gears can work to bring your robot to life.

Have students take out the different gears from the set to look at them and talk about their characteristics. Ask students to think about where they have seen gears before.

Have students complete the "First Gear" lesson (see lessons in Resources section of website). Review theory of gears with students and have students write important vocabulary and what a gear ratio is in their journals. Have students build the gear model (building instructions on the website). Students should complete the predict, run and observe activities and answer the questions in their journal. Students should continue through the lesson changing the gears as prompted and completing the predict, run, and observe questions.

After their investigation, ask students to think about and explain and perhaps add notes in their journals:
- How did the model work?
- How do gear ratios work?
- How can you change the gear ratio in your robot?
- How does changing gears affect the way the robot works?
- What areas of industry utilize gears and where do you think gears are working, even if you don't see them?

Break
Time: 5 minutes

Disassemble and Inventory Check
Time: 15 minutes
Materials:
- EV3 set

Ask students to take apart their gearing model. Then, working with a partner, students will work to conduct an inventory check of the pieces in their set to ensure all pieces are in the correct locations and that no pieces are missing.

For a full inventory check: Have students place elements from one tray compartment onto the lid of the box. Then, using the paper inventory sheet in the set (the one that is placed under the lid of the box) have students count and replace pieces back into the tray compartment. Teams should be able to complete two compartments in ten minutes. If pieces are missing, have students search other compartments, look to see if the piece is stuck in or on another piece in the bottom of the box, or check the LEGO lost and found area in your classroom.

For today, we suggest you conduct only a “quick inventory” of the sections that pieces from the gearing model came from. Students will not need to count pieces from all sections. Two compartments will be a quicker check of their materials and give them the idea you are serious about keeping the sets in order.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Sticky notes
- Student journals
- Pencils
- Pens
- Markers

Make sure EV3 bricks are plugged in overnight to charge the battery.
Devices should be powered off and plugged in or stored for the next day.

Have students use sticky notes to write down three things they really enjoyed about the day. Have students use a different sticky note to write down one thing they are still wondering about. Place the sticky notes in the student journals.

Robotics at Work Day 2
Robots at Work: Move like a Robot

Big Questions:

- What types of work do robots do?
- Are all robots wheeled vehicles?

Materials:

- EV3 sets
- Devices with EV3 software
- Chart paper
- Student journals
- Various craft materials
- Pens
- Pencils
- Markers

Day 2: Outline for the day

Outline of Day	Tasks	Time	Materials
9:00 - 9:50	Welcome	5 min	• Student journals
	Team building activity	15 min	• LEGO bricks • Bricktionary cards
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing 2	5 min	• None
	Readings and Wonderings	20 min	• Book or journal article about robots in industry
9:50 - 10:50	Challenge 1: Build a Robot	60 min	• EV3 sets • Devices with software • Student journals
10:50 - 10:55	Break		

10:55 - 11:25	Workplace Wellness	15 min	• Varies, based on the activity selected
	Team Briefing 2	5 min	• None
	Challenge 2: Move like a robot	10 min	• EV3 set • Devices • Student journal
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 12:35	Challenge 2: Get Moving Continued	35 min	• EV3 set • Devices • Student journal • Tape • Minifigs
12:35 - 1:25	Challenge 3: Moving Without Wheels	45 min	• EV3 set • Devices • Student journal • Tape
	Break	5 min	
1:25 - 2:10	Challenge 3: Continue Moving Without Wheels	45 min	• EV3 set • Devices • Student journal • Tape
2:10 - 2:30	Daily Debrief and Wrap Up	10 min	• Student journals

Exploration
Time: 5 minutes
Materials:

- Student Journals

Welcome students back. Have students take a minute to read over the sticky notes placed in their journals from the previous day. Have students share their favorite moments from the previous day with a partner.

Team Building Activity
Time: 15 minutes
Materials:

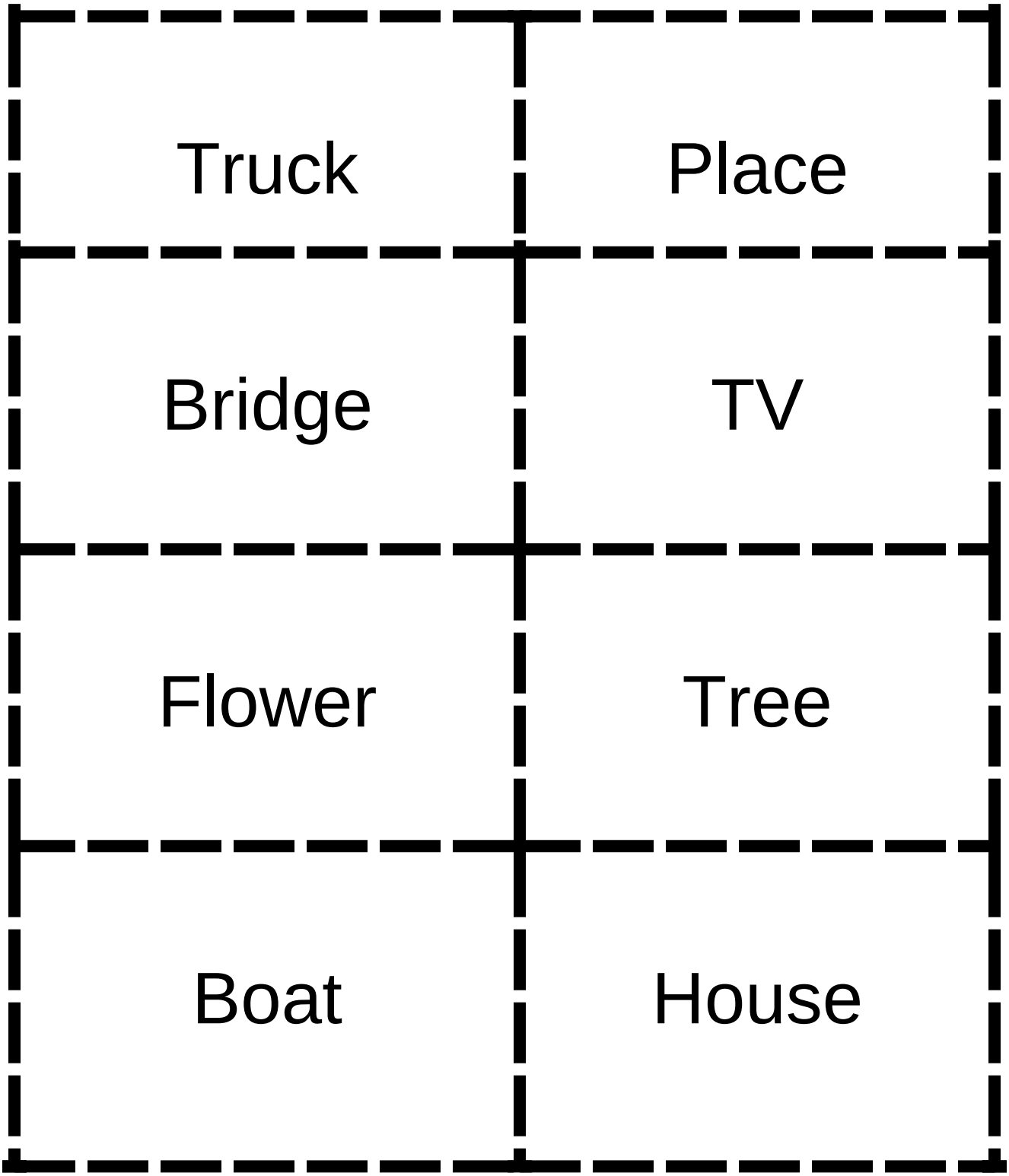
- Loose bricks

- Cards with objects to build

Place students in groups of 4-5 for team building activity — Bricktionary.

Bricktionary:
Have students play one round of Bricktionary. Similar to Pictionary, students will draw a card from the stack without showing the word to their teammates. Then using bricks, students will build the object while teammates try to guess what it is. Game is over when everyone has had a turn.

Bricktionary Cards



Review group rules and expectations
Time: 5 minutes
Materials:

- Group Rules Chart

Quickly review the group rules and expectations created on Day 1 by the students.
Highlight positive moments from Day 1 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1

> *Hello, fellow engineers! Your task today is to work with different types of robots. Yesterday you worked with a robot that used gears to move at different speeds. Some robots are wheeled vehicles; others are not*.

Readings and Wonderings
Time: 20 minutes
Materials:

- Internet research on companies that make, sell, or use robots.
- Videos on robots that are used in industry, health care, or home.
- Student journal

Read and discuss companies that make, sell or use robots.
Have students write what type of robots are used, made, or sold in the local area.

Challenge 1: Building your first robot
Time: 60 minutes
Materials:

- EV3 Sets
- Device with software
- Student journals

Students will use the knowledge gained from how motors and sensors work in order to build a driving base.
Find the Straight Move lesson and select the building instructions for the driving base robot. Have students complete the build to build a full robot.
While the students are building, ask them question about how the robot is designed. Ask students to think about how the motors are attached. How do they anticipate how the robot will move based on the way it is built? Have students begin to discuss the ways that they can make the robot move.

As students finish building, allow them to start programming the robot to move to investigate their ideas.
Have students write a brief reflection on the activity in their design journals.

- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Break
Time: 5 minutes

Workplace Wellness
Time: 15 minutes
Materials:

- Vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place. Consider having students move like a robot to prepare them for the next challenge.

Team Briefing 2
Time: 5 minutes
Materials: None

> *Now that you have investigated why people want to explore and you have built a tool used for exploration, I am presenting you with a new challenge. I would like for you to investigate what scientists and engineers do when they cannot go where they want to explore. To help with your investigation, you are going to program a rover to complete several different types of movements.*

Challenge 2: Move like a robot
Time: 45 minutes
Materials:

- EV3 Sets
- Device with software
- Student journals
- Mini-figures
- Tape

Preparation:
Set up two stations.

- Station 1 will challenge students to drive in a straight line without hitting the mini-figure. Set up several lines for the robot to drive along with a mini-figure at the end of the line. Students will have to learn to program the movement of the robot to be precise enough to not hit the mini-figure.
- Station 2 will challenge students to drive their robot in a perfect square which will challenge the students to develop longer programs that include straight lines and accurate turns. Create a square using the tape for students to drive along.

Challenge
Scientists have to control their robots' movements very carefully to ensure that the robots are not damaged and that the robots do not damage anything else. In this challenge, students need to learn to control their robots' movements by ensuring the robots do not run over any mini-figures.

Once the students have created and run their programs in each station, ask them to think about and explain the program and the function of the robot.

They should be able to answer questions verbally and in their journals.

- How does the program work?
- What do the different program blocks do?

Keep the robots built and have students reflect in their journals:

- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Lunch
Time: 30 minutes
Lunch will fall in the middle of Challenge 2. Allow students to start the challenge and then complete it after lunch.

Complete Challenge 2: Move Like a Robot
Time: 35 min
Materials:

- EV3
- Devices with EV3 software
- Student journals

Use more time if needed to complete.

Challenge 3: Move Without Wheels
Time: 45 min
Materials:

- EV3 sets
- Device with EV3 software
- Student journal
- Tape

Students today will make a vehicle without wheels that can move one meter. Tape a starting line and a finish line exactly one meter apart. Explain to the students where they will start and where the robot must go past.

Be specific about position of the robot at the starting line – i.e., Will you allow any part of the robot to touch or go over the starting line? Does the entire robot have to pass the finish line or just have one part of the robot go beyond the finish line?

You can choose to allow students to start from scratch and build a robot OR you can have them take apart the driving base and let them reconfigure. Their job is to create a robot without wheels that can move from starting line past the finish line. This is going to take many iterations.

They should write in their journals about what they try, how well the model and program work, and what they modify.

If you wish, you can allow students to look on the internet for ideas – but I wouldn't allow that until they have tried for at least 45 minutes. They need to think and work together. Once teams start to be successful, I would time them and write it on the board so they will see how quickly these robots can move. Allow others to copy ideas that were successful.

Daily Debrief and Wrap Up
Time: 10 minutes
Materials:

- Student journals
- Markers
- Colored pencils
- Crayons

Have students write one word that they feel reflects what they have learned today. Write and illustrate the word in their student journals.

Robotics at Work Day 3
Robots at Work: Make it Move

Big Question:

- How do robots use a sensor that detects an object?

Materials:

- EV3 sets
- Devices with EV3 software
- Student journals
- Various craft materials
- Pens
- Pencils
- Markers

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Welcome	5 min	• Student journals
	Team building activity	15 min	• LEGO bricks
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing	5 min	• None
	Readings and Wonderings	10 min	• Internet research
	Inventory Check	5 min	• EV3 set
	Challenge 1: Stop at an Object	45 min	• EV3 set • Device with EV3 software
10:35 - 10:40	Break		
10:40 - 11:25	Challenge 1: Stop at an Object, Continued	45 min	• EV3 driving base • Device with EV3 software • Student journals
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		

12:00 - 2:10	Workplace Wellness	10 min	• Varies, based on the activity selected
	Team Briefing 2	5 min	• None
	Challenge 2: Turn, Turn, Turn	90 min	• EV3 Driving base • Student journals
	Challenge 3: Boomerang	30 minutes	• EV3 Driving base • Student journals
2:10 - 2:30	Daily Debrief and Wrap Up	15 min	• Student journals

Welcome
Time: 5 minutes
Materials: Student Journals
Welcome students back. Have students take a minute to share their word they create the day before with a neighbor. Compile a list of the words as a group. You can create a word cloud to share on the last day of the program.

Team Building Activity
Time: 15 minutes
Materials: LEGO bricks
Place students in pairs.

Build a Bridge
Challenge students to build a LEGO bridge that spans two tables.

Extensions:
- Build the longest bridge
- Build the tallest bridge
- Build a bridge that can the most weight (use a bucket and some weights to test)

Review group rules and expectations
Time: 5 minutes
Materials:
- Group Rules Chart

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 2 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1
Time: 5 minutes

Materials: None

Hello! This morning, your task is to investigate different ways we use robots that use a sensor to detect an object. Who in the area makes, uses, or sells robots that uses a sensor to detect an object? How and why are the robots used?

Research and Wonderings
Time: 10 minutes
Materials:

- Student journals

Discussion and Internet search on local area businesses that use, make, or sell robots with a sensor that detects an object.

Inventory Check
Time: 5 minutes
Materials:

- EV3 set

Ask students to find their partner from Day 1. Have students check to see all items in the bin are in the proper trays. Students will be adding to their driving base today.

Challenge 1: Stop at an Object
Time: 45 minutes
Materials:

- EV3 Sets
- Devices with EV3 Software

Add an ultrasonic sensor to the driving base. Have students go through the tutorial of **Stop at an Object.** Then, challenge them to write a program that stops their robot 15 cm from the wall.

Have students run their program at multiple different power levels and chart and then graph the results. They should see that the robot is much more accurate at lower power levels than at higher levels. Speed is in opposition to accuracy.

Next, have students do the same measurements at different power levels again, but starting perpendicular to the wall and then moving 10-15 degrees around an arc toward the wall. Talk to them about the geometry effect of bouncing signals.

Students should work for about 45 minutes, then take a break.

Break
Time: 5 minutes

Challenge 1: Stop at an Object Continued
Time: 45 minutes
Materials:

- EV3 Sets
- Devices with EV3 Software

- Student journals

Lunch
Time: 30 minutes

Workplace Wellness
Time: 10 minutes
Materials:
- Vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place.

Team Briefing 2
Time: 5 minutes
Materials: None

Today you will make your driving base practice three different turns and then create a boomerang robot.
There are three types of turns:
- *Point – one motor (wheel) turns clockwise, the other motor (wheel) turns counterclockwise; this is the tightest turn like on a zero-turn radius mower*
- *Pivot – one motor (wheel) turns, the other motor (wheel) does not turn; this is a turn like a basketball player uses when she has the ball*
- *Arc – both motors (wheels) turn in the same direction, but each motor turns at a different power level; this is the turn your car makes with the front tires*

Challenge 2 Turn, Turn, Turn
Program Your Robot - Move Steering block

a. Point turn clockwise for 90 degrees
b. Point turn counterclockwise for 90 degrees
    - Point turn – Move Steering block – Steering at 100 or -100
    - Pivot turn – Move Steering block – Steering at 50 or -50
    - Arc turn – Move Steering block – Steering between 1 and 49 (shows well in 20-30s)

Program You Robot - Move Tank block
- Point turn – Move Tank block – Power levels are the same values, but one motor is positive power and the other motor negative power
- Pivot turn – Move Tank block – One motor has a power level of 0 and the other has any power level
- Arc turn – Move Tank block – neither motor has a power level of 0; the motors have different power levels

Answer the following in your journal:

- Why is the rotation input in the Move Tank Block not the same as the rotation of the robot?
    - The degrees input in the block corresponds to motor rotation, not robot rotation. Students often assume a 90-degree motor turn is equal to a 90-degree driving base turn. They are in two different planes of motion. The motor is going clockwise or counterclockwise in one plane but the robot is moving in a perpendicular plane.

Before moving forward create a table with the following three column headers: (all measurements are in degrees)

Degrees in the Programming of the Block	Predicted Rotation of the Robot	Measured Rotation Robot

Reprogram Your Robot

a. 75 degrees clockwise
b. 225 degrees clockwise
c. 15 degrees clockwise

Note: Create the start positions using tape on the floor before the students begin the challenge. See Challenge 3 for more information.

Challenge 3: Boomerang
Time: 30 minutes

- Materials:
  EV3 driving base
- Device with EV3 Software
- Student journals

Create a new program to move your robot from the start position to go around an object and return to the start position. Test your program and document your results.

If time remains after a team has completed on the floor, move to a different surface – for example from carpet to tile or tile or concrete. Students will have to adjust their programs based on friction.

> **Teacher Note:** Small variations in where the robot starts (slightly left or right instead of straight forward) will drastically affect the end position. The varying turning point of the low-profile wheels makes this task challenging to reproduce with precision.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- LEGO bricks
- Student journals

- Camera or something to take a picture

Have students use LEGO bricks to build a model that represents two things they learned today. Have students take a picture or draw a sketch of the model. Students should add some notes regarding their models in their journals. Use pictures to create a collage for display for Day 5.

Note: You should leave the models intact.

Robotics at Work - Day 4
Robots at Work: Make it Smarter

Big Question:

- How can sensors make a robot smarter?

Materials:

- EV3 sets
- Devices with EV3 software
- Student journals
- Chart paper
- Various craft materials
- Old magazines that can be cut up (optional)
- Pens
- Pencils
- Markers
- Glue sticks

Outline for Day	Tasks	Time	Materials
9:00 - 10:45	Welcome	5 min	• Student journals
	Team building activity	15 min	• LEGO bricks
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None
	Research and Wonderings	10 min	• Discussion • Internet research • Student journals
	Inventory Check	5 min	• EV3 sets
	Challenge 1: Turn Using Gyro Sensor	60 min	• EV3 sets • Devices with EV3 software • Student journals
10:45 - 10:50	Break		

10:50 - 11:25	Challenge 1: Turn Using Gyro Sensor continued	35 min	• EV3 sets • Devices with EV3 software • Student Journals
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Workplace Wellness	10	• Varies, based on the activity selected
	Challenge 2: Detect a Color; Stop at a Line;	120 min	• EV3 sets • Devices with EV3 software • Student journals
2:10 - 2:30	Daily Debrief and Wrap Up	20 min	• Student journals

Welcome
Time: 5 minutes
Materials:
- Student journals

Welcome students back. Have each student share their models from Day 3 with a friend.

Team Building Activity
Time: 15 minutes
Materials:
- LEGO bricks

Create a Creature
Have each student create a LEGO creature. Have them give their creature a name and a special characteristic. Have students share their creature with their partner. Have the pair create a short story that includes both creatures.

Review Group Rules Chart
Time: 5 minutes
Materials:
- Group Rules Chart

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 3 (times when students helped each other, asking great questions, teamwork, helping to clean up…).

Team Briefing 1
Time: 5 min
Materials: None

Today you will investigate using a gyro sensor to make precise turns and a color sensor to detect color and react.

Research and Wonderings
Time: 10 minutes
Materials:

- Discussion and internet research
- Student journals

Determine what companies in the area make, use, or sell robots that detect color.

Inventory Check
Time: 5 minutes
Materials: EV3 set
Ask students to find their partner from Day 1. Have students confirm that all pieces in the bin are in the correct tray compartments.

Challenge 1: Stop at an Angle
Time: 60 minutes
Materials:

- EV3 sets
- Devices with EV3 software
- Student journals

Students should work with their Day 1 partners.

Turn Using Gyro Sensor
Rotating using a wheel is not very precise. If you try to turn your robot in the dust or on a slippery surface, it may not reach the right angle. The Gyro Sensor helps you make more precise movements.

Your mission is to program your robot to complete a point turn to an exact angle by using the Gyro Sensor. Add the Gyro sensor to the driving base.
https://education.lego.com/en-us/support/mindstorms-ev3/building-instructions#robot

Complete the tutorial **Stop at Angle.**

Create Your Program

- Move Tank Motors On, Motor B Power 10, Motor C Power -10
- Add a Wait for Gyro Sensor Greater Than or Equal to 90
- Move Tank Motors Off

Place your robot on starting position on the circle you created with tape.

Note: When using the Gyro Sensor, the value of rotation written in the sensor block corresponds to the rotation of the driving base. The precision of the sensor is +/- 3 degrees.
The motor slack and the delay caused by stopping the rotational momentum can also affect the precision.
The power of the battery, the size of the wheels, the friction of the robot on the surface, the distance between the two wheels are no longer factors that can influence the precision of the rotation of the robot.

Describe what each part of your program made your robot do in your journals.

Estimate the rotation angle of your robot.
Explain the difference between the rotation of your robot with and without the Gyro sensor. Use the angle measurement shown on the gyro sensor area of the device screen. Don't forget to reset it to zero for best results.

Break
Time: 5 minutes

Challenge 1: Turn Using Gyro Sensor continued
Time: 15 minutes
Rebuild your program to make your robot do the following point turns:

a. Clockwise for 45 degrees
b. Clockwise for 180 degrees
c. Clockwise for 360 degrees followed by a counterclockwise point turn for 360 degrees

Describe in your journal how much your robot rotated compared to what the program told it to do.

1. Create a new program using a loop to make your robot drive in a square that is 1 meter per side.
2. Test your program by placing your robot in a starting position and having it end in the same starting position. (tape on the floor)
3. Explain what a loop can be used for in your journals.

Now, program your robot to make various patterns.

- Can you drive in a triangle?
- Can you drive an octagon?
- Do robots ever need to move in the same pattern over and over again? If so, why?

Tape starting positions that will be the ending position when the pattern has been repeated

Lunch
Time: 30 minutes

Workplace Wellness
Time: 10 minutes
Materials:

- Vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas include simple exercises like jumping jacks or running in place.

Challenge 2: Detect a Color; Stop at a Line
Time: 120 minutes
Materials:

- EV3 driving base
- Device with EV3 software
- Student journals
- Tape
- Colored paper or paper with different color lines

Student will add a color sensor and use it. Continue with **Detect a Color**. Students will need to add a sensor and will need the sets. Students should complete the tutorials **Stop at Line** before completing the **Detect a Color**. Students will need to journal their findings and answer the questions. Students should video their robot if possible.

Your robot should read colors in an area to help identify its position.
Your mission is to program your robot to take various actions while reading color lines on the floor.

Add the Color Sensor in the Down Position.
https://education.lego.com/en-us/support/mindstorms-ev3/building-instructions#robot

Complete the **Stop at Line** tutorial.

Create Your Program

- Move Steering – Motors On, Power 30
- Add Wait for Color Sensor, Compare, Color, Black
- Add Move Steering – Motors Off

Place your robot on the floor with multiple lines about 1 inch wide, each of a different color. They can be made of colored paper or tape. Check to see the color sensors recognize the colors as LEGO red, LEGO blue, etc.
Describe what each part of your program made your robot do in your journal.

Create new programs to make your robot move forward and stop at the:

a. First white line
b. Second black line and make a sound when it detects it
c. Red line or blue line

Explain how you made your robot perform the different tasks.

Previously the students created a program that allowed their robot to stop at a wall. Today we are going to work on detecting an object. How and why would a robot want to use a sensor to detect objects?

Complete **Detect an Object**. Students will need to add a sensor and will need the set. Students should complete the tutorials **Move Object** and **Stop at Object** before continuing the **Detect an Object** lesson. Students will need to journal their findings and answer the questions. Students should video their robot if possible.

Collecting objects or moving them around are common purposes of robots. Your mission is to program your robot to detect an object and collect it.

Add the Ultrasonic Sensor to the driving base.
Build the Cuboid. (Multicolored cube)
https://education.lego.com/en-us/support/mindstorms-ev3/building-instructions#robot

Complete the Move Object tutorial.

Complete the Stop at an Object tutorial.

Create Your Program
Move Steering Motor On Power 20
Add Wait For Ultrasonic Sensor Compare Distance in Centimeters Less than or equal to 12 cm
Add Move Steering Motor Off
Place the cuboid on a given position (taped on floor) and the robot on a taped starting position.

Write in your journal. Describe what each part of your program made your robot do and how well your program worked. How many times did you have to rebuild or reprogram to make it work precisely? What issues did you have to overcome?

Create a new program to move your robot:

a. Forward and stop 5 cm away from the Cuboid.
b. Forward and stop as close as possible to the Cuboid. Place the Cuboid at any of the three positions. (taped)
c. Place your robot on the starting position and run your program. Run each program three times and measure the distance between the sensor and the object.

After the robot has stopped within 5 cm of the object three times, calculate the average of the three measured distances between the sensor and the object. Journal your findings.

Create a new program that moves your robot close enough to the Cuboid to grab it with the Medium Motor Module, then drive back to the start position.

a. Add the Medium Motor Module.
b. Download the program, place your robot on starting position with the Cuboid located on a taped area and run the program.

In your journal, describe how your robot worked the first time you tried the program. What adjustments did you have to make in order to make your robot work exactly?

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Student journals
- Old magazines that can be cut up
- Colorful paper
- Markers
- Stickers
- Glue sticks

Ask students to create a “self-portrait” collage that only uses positive words about themselves. Have them include words related to positive contributions they can make to a team! Place collage in their student journals.

Robotics at Work: Day 5
Design Challenge Day

Outline for Day	Tasks	Time	Materials
9:00 - 10:30	Welcome and Team Building Activity	10 min	• LEGO bricks
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing	5 min	• None
	Prepare for the Showcase	10 min	• None
	Challenge: Showcase Work Time	60 min	• EV3 sets • Devices • Craft materials
10:35 - 10:40	Break		
10:40 - 11:25	Challenge: Set up for Showcase	45 min	• EV3 sets • Devices • Student projects
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 1:30	Showcase	90 min	• Student Projects
1:30 - 2:30	Daily Debrief, Clean Up and Robotics at Work Wrap Up	60 min	• EV3 sets • Certificates of Completion

Welcome
Time: 5 minutes
Materials:

- Student journals

Welcome students back. On a piece of chart paper, draw a really large light bulb. Have students write positive things they discovered about themselves during the program. Students can use their reflection on the end of Day 4 for ideas.

Team Building Activity
Time: 15 minutes
Materials:

- LEGO bricks

Build Something That

- Work in groups of 4-5.
- Place the bricks in front of you.
- The teacher will name a category.
- As a group, build an 2-3 items that belongs in this category.
- When done building, please explain why each item belongs in the category.

Build Something That

- *can fly*
- *is an animal*
- *can be used for transportation*
- *you can have for lunch or dinner*

Tip: Ideas for other categories: a movie, cartoon characters, buildings, etc.

Team Briefing
Time: 5 minutes
Materials: None

Today, your mission is to show your skills to others. You will need to make sure your team is prepared. Your team will develop a maze that allows you to program your robot using all the skills you have learned. You will be showcasing your maze and showing your robot complete the maze. Be sure to practice running the robot through the maze several times and be prepared to explain the programming to the audience.

Showcase overview and expectations
Time: 10 min
Materials: None
Go over your expectations for the students at the showcase in the afternoon so students are prepared for guests.

Culminating Project: Group Work
Time: 60 minutes
Materials:

- EV3 sets
- Devices with EV3 software
- Craft Materials

This is time set aside for groups to work on culminating project.

Break
Time: 5 minutes

Culminating Project: Set up for Showcase
Time: 45 minutes
Materials:
- EV3 sets
- Devices with EV3 software
- Maze building materials

Pair up teams and have them practice running their mazes.

Lunch
Time: 30 minutes

Showcase: Running the Maze
Time: 90 minutes
Materials:
- Student work

Students should be set up and ready when guests arrive.

Other materials you might have on display:
- Charts created during the week
- Pictures
- Videos from the week

Daily Debrief, Clean Up and Wrap Up
Time: 60 minutes
Materials:
- Student projects
- Certificates

Have students disassemble their EV3 models. Make sure sets have the EV3 brick, motors, sensors and sets are in good order. Make sure devices are powered off and stored.

Have students clean up materials from the showcase.

Students can take home their journals.
You can present each student with a certificate of completion.