Instructor Guide

Title: Distance the robot will travel based on wheel size

Introduction

Calculating the distance the robot will travel for each of the duration variables (rotations, degrees, seconds) can be confusing for participants especially when coupled with a turn or a spin. It is important to remember that rotations and degrees reference the wheel axle, such that these distances can change depending on the size of the tire installed on the robot. This activity outlines how to use the duration variables correctly to make corner turns and to calculate the distance to objects using the circumference of the tire. The answers provided in the instructor guide are based on the basic bot construction from the LEGO® EV3®.

Objectives

Youth will apply basic math functions and geometry.
Youth will gain experience with units of measurement and measurement comparison.
Youth will demonstrate creativity, innovation and critical thinking skills.
Youth will increase their ability to work collaboratively with others.
Youth will better understand the process of programming and evaluating robotic movements.

Preparation and Materials

One-12 inch ruler per robot

Activity: How far will your robot travel?

Take a look at the larger tires connected to the gear motors on the NXT robot. On the side of these tires there are numbers. This is true for *all* tires and tells you the size (diameter and width) of the tire. Automobile tires and bicycle tires also have these numbers to ensure the mechanic places the correct tire size on each axle.

1. What are the numbers on the robots large tire?

   56 X 28

2. Are these numbers are in inches, centimeters or millimeters?

   Millimeters

3. Which number is the diameter and which is the width?

   56 mm = diameter

   28 mm = width

4. Using the diameter of the tire, one can find the *Circumference* of the tire. The circumference of a tire tells the distance a tire travels in one revolution:

   $C = \pi D$

   Where C= circumference, π = 3.14, and D = diameter

What is the circumference of the NXT tire?

3.14
X 56
1884
15700
175.84 mm

This means one rotation of the tire is 175.84 mm or 17.6 cm.

5. If one rotation is equal to 17.6 cm, how many cm will the robot travel in three tire rotations?

   17.6 X 3 = 52.8 cm

6. Since the wheel of the robot is a circle, one can also speak about degrees of tire rotation. How many degrees does the tire rotate for each tire rotation?

   1 tire rotation – 360 degrees

7. How many cm will the robot travel if it is programmed to travel a duration of 720 degrees?

   720 degrees = 2 tire rotations = 35.2 cm

However, the robot might not travel the distance you calculated. There are several variables that affect the distance travelled by the robot:

- The **power level setting** will affect distance traveled when using the time interval in seconds; however, it will not affect the distance travelled in rotations or degrees. In addition the battery life levels will also impact the amount of power provided to the robot to complete the moves.
- The external environment will impact the amount of **friction** on the tires. A smooth surface will have less friction meaning the robot will travel slightly faster. A carpeted surface will have more friction meaning the robot will travel slightly slower.
- The **mechanics** of the built robot impacts the function of the robot. For example if a tire is not perfectly aligned on the wheel well or on the axle you may experience a wobbly wheel.
- The **temperature** will affect the distance travel. Since the wheels are made out of rubber, they will slightly expand when the temperature is hot and contract with the temperature gets colder.

Instructor Guide
Challenge Title:

EV3 Bark Like a Dog

Introduction
This robotic challenge does not need a challenge mat. Youth can use their hand to activate the touch sensor. The robot configuration must include the touch sensor to complete the challenge.

Objectives
Youth will demonstrate creativity, innovation and critical thinking skills.
Youth will increase their ability to work collaboratively with others.
Youth will be able to improve communication skills.
Youth will better understand the process of programming and evaluating robotic movements.
Youth will increase their ability to design a solution to a challenge.

Level of Difficulty ☆

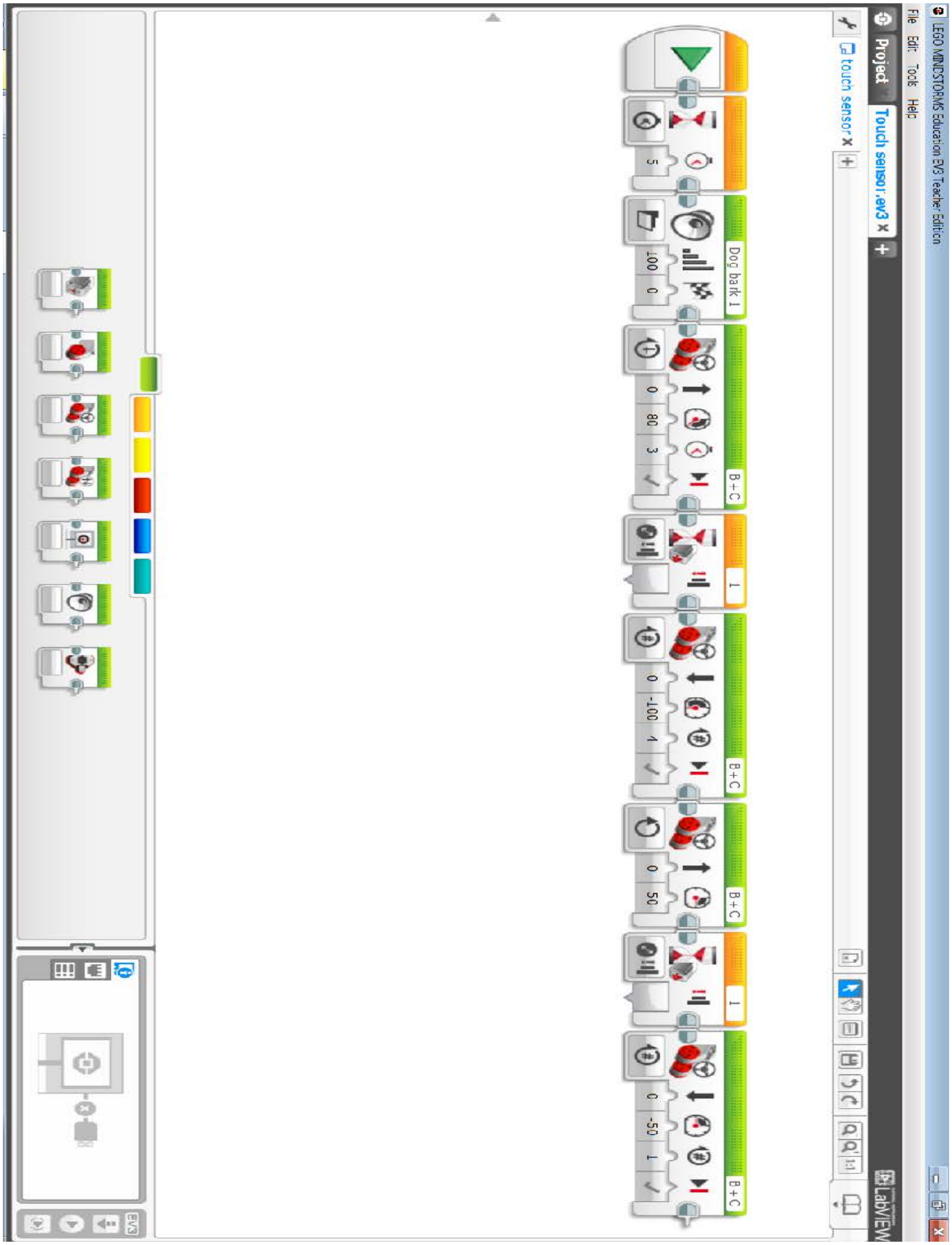
Preparation and Materials
Instructor should determine teaching methodology (text instructions or pictorial programming guide) that best fits the audience.
Print appropriate student materials.

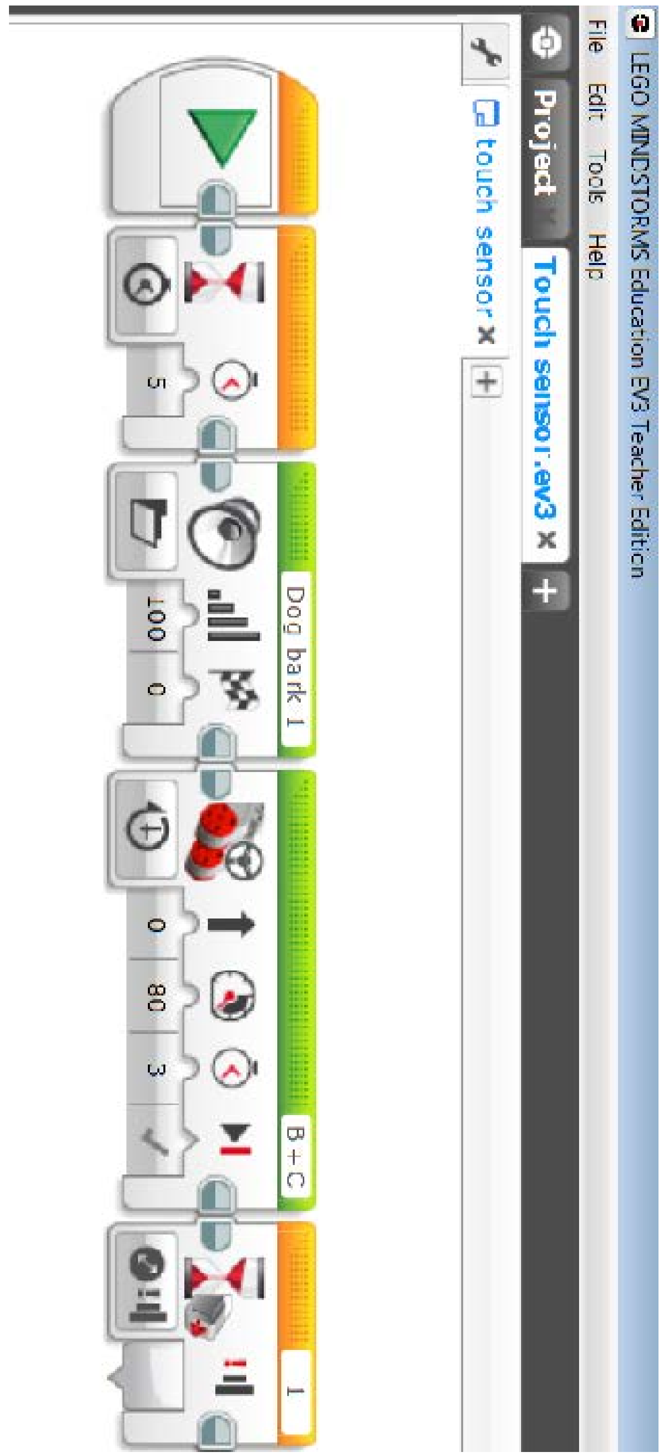
Time Required
Programming: 15 minutes (if participants are given text instructions only).
To run the course: less than a minute.

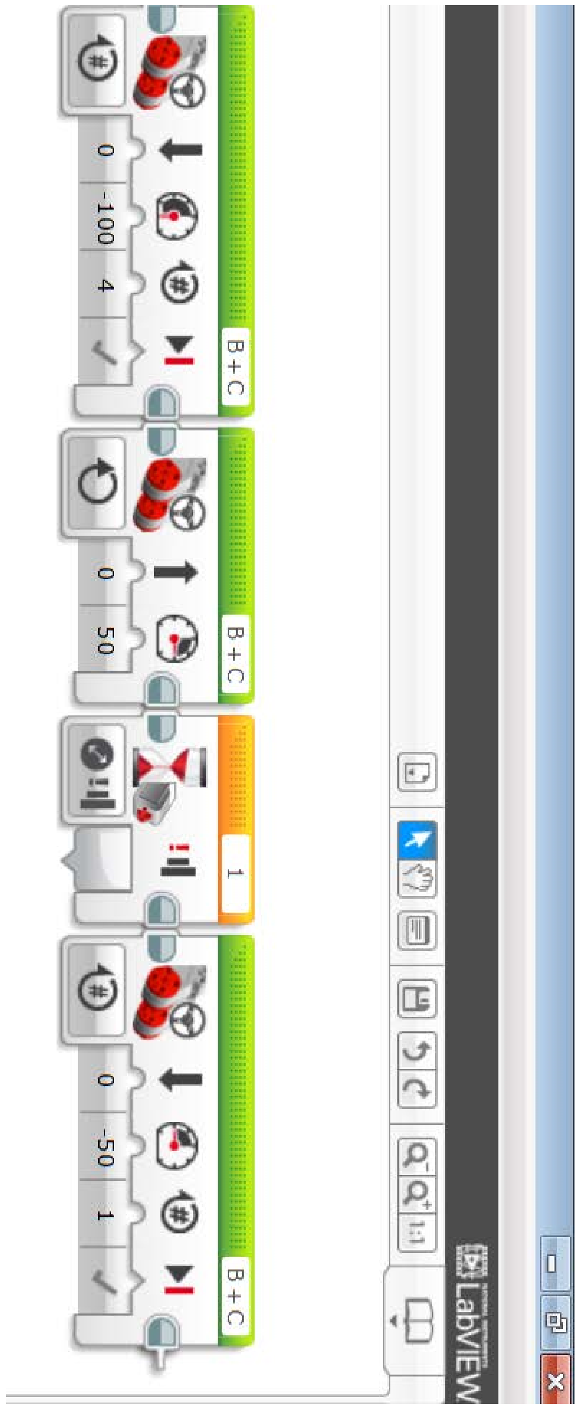
Procedure of Programming Steps
Depending on the expertise level of the participants, the instructor can give the youth the text of the steps involved in the challenge or give them the complete pictorial programming guide.

TEXT:
1. The robot waits five seconds before starting the program.
2. The robot barks like a dog.
3. The robot moves forward for 3 seconds at 80% power.
4. The robot stops and waits for you to press the touch sensor.
5. The robot moves backwards four tire rotations.
6. The robot moves forward and uses the touch sensor to hit an obstacle (youth can use their hand to activate the touch sensor).
7. The robot moves backwards one tire rotation and stops.

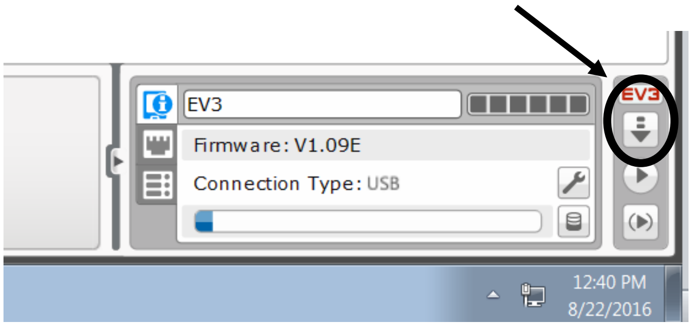
COMPLETE PICTORIAL PROGRAMMING GUIDE:




LEGO MINDSTORMS Education EV3 Teacher Edition
File Edit Tools Help
Project
Touch sensor.ev3
touch sensor
Dog bark 1
B + C
1


B + C
1
LabVIEW

A. Connect the computer and the robot using the USB cord and make sure the robot is turned on.
B. Download the program onto the robot by pressing the download button at the bottom right corner of the computer screen.



C. Disconnect the robot from the USB cord.
D. Find the program on the robot and use the dark gray button to start the program.

Discussion Questions

What difficulties did you encounter with the programming?

What did you do to overcome these difficulties?

What other things might use a touch sensor?

Automatic car wash

Touch screens

What was the difference in the programming for the touch sensor in Step 3 versus Step 6?

The robot was stopped and waited for you to touch the touch sensor in Step 3. In Step 6 the robot moved until the touch sensor was activated. In the programming, you alter the move block before the sensor block.

Why did you need to select "on" for the move block in Step 6?

You needed to select "on" because you didn't know how far away the obstacle was that would activate the touch sensor.

Instructor Guide

Challenge Title:

EV3 Four Bricks

Introduction:

There is no challenge mat for this activity and no sensors need to be connected to the robot. This challenge introduces participants to the move block and the relationship between the different duration types: rotations, degrees and seconds.

Objectives

Youth will demonstrate creativity, innovation and critical thinking skills. Youth will increase their ability to work collaboratively with others. Youth will be able to improve communication skills. Youth will better understand the process of programming and evaluating robotic movements. Youth will increase their ability to design a solution to a challenge.

Level of Difficulty ★

Preparation and Materials

Instructor should determine teaching methodology (text instructions or pictorial programming guide) that best fits the audience.
Print appropriate student materials.

Time Required Programming:

5-10 minutes (if participants are given the text instructions only).

To run the course: less than a minute.

Procedure of Programming Steps

Depending on the expertise level of the participants, the instructor can give the youth the text of the steps involved in the challenge or give them the entire pictorial programming guide.

TEXT:

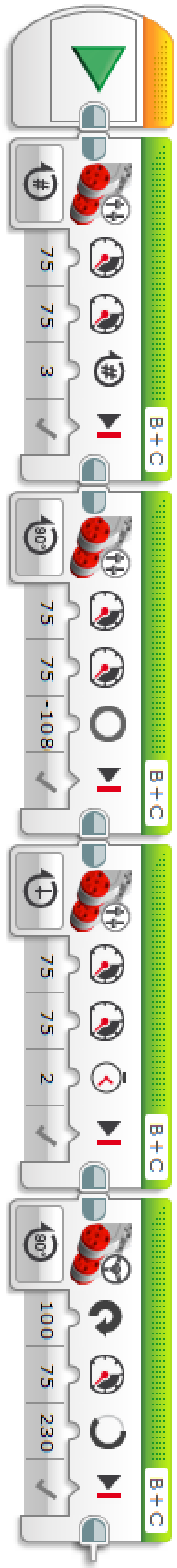
1. Robot moves forward three tire rotations at 75% power.

2. Robot moves backward 1080 degrees at 75% power.

3. Robot moves forward for two seconds at 75% power.

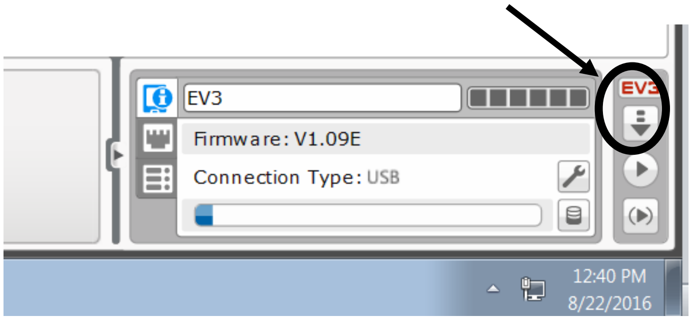
4. Robot moves forward while making a hard turn toward the right for 230 degrees at 75% power

Program Guide



Connect the computer and the robot using the USB cord and make sure the robot is turned on.

A. Download the program onto the robot by pressing the download button at the bottom right corner of the computer screen.



B. Disconnect the robot from the USB cord.

C. Find the program on the robot and use the dark gray button to start the program.

Discussion Questions

What difficulties did you encounter with the programming?

What did you do to overcome these difficulties?

How did the distance traveled by the robot in step 1 compare to the distance the robot traveled in step 2?

Instructor Guide
Challenge Title:

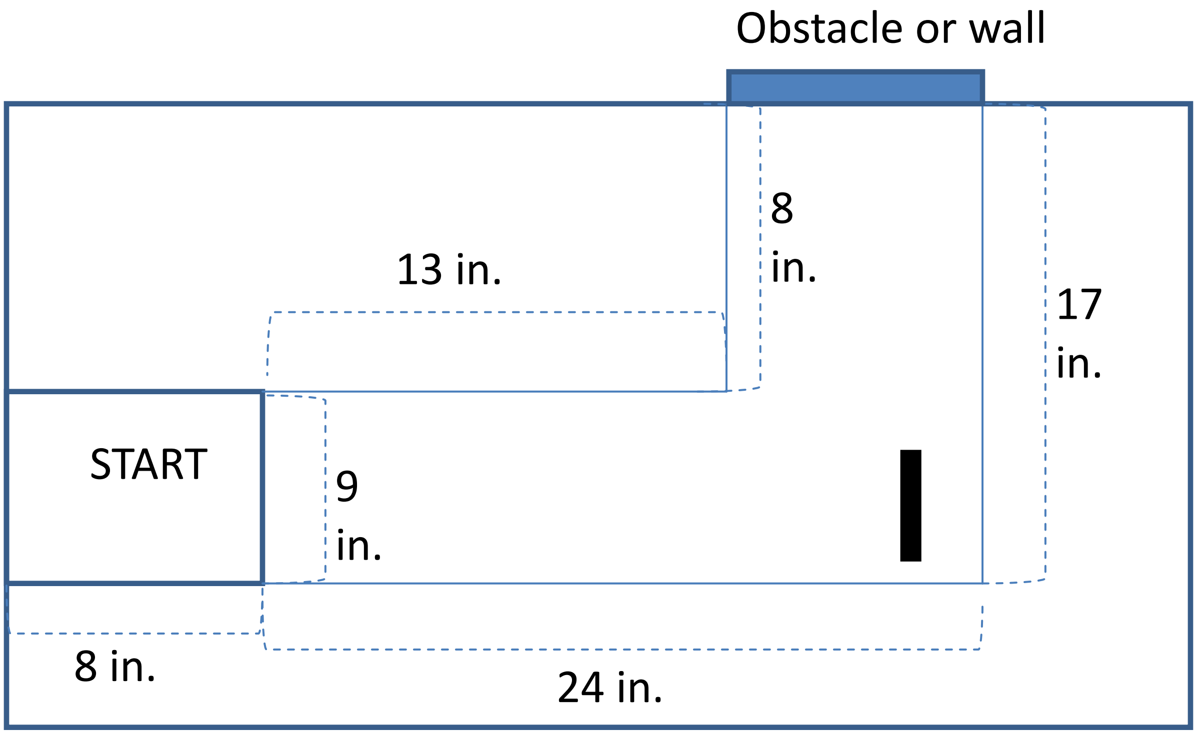
EV3 Magic Touch

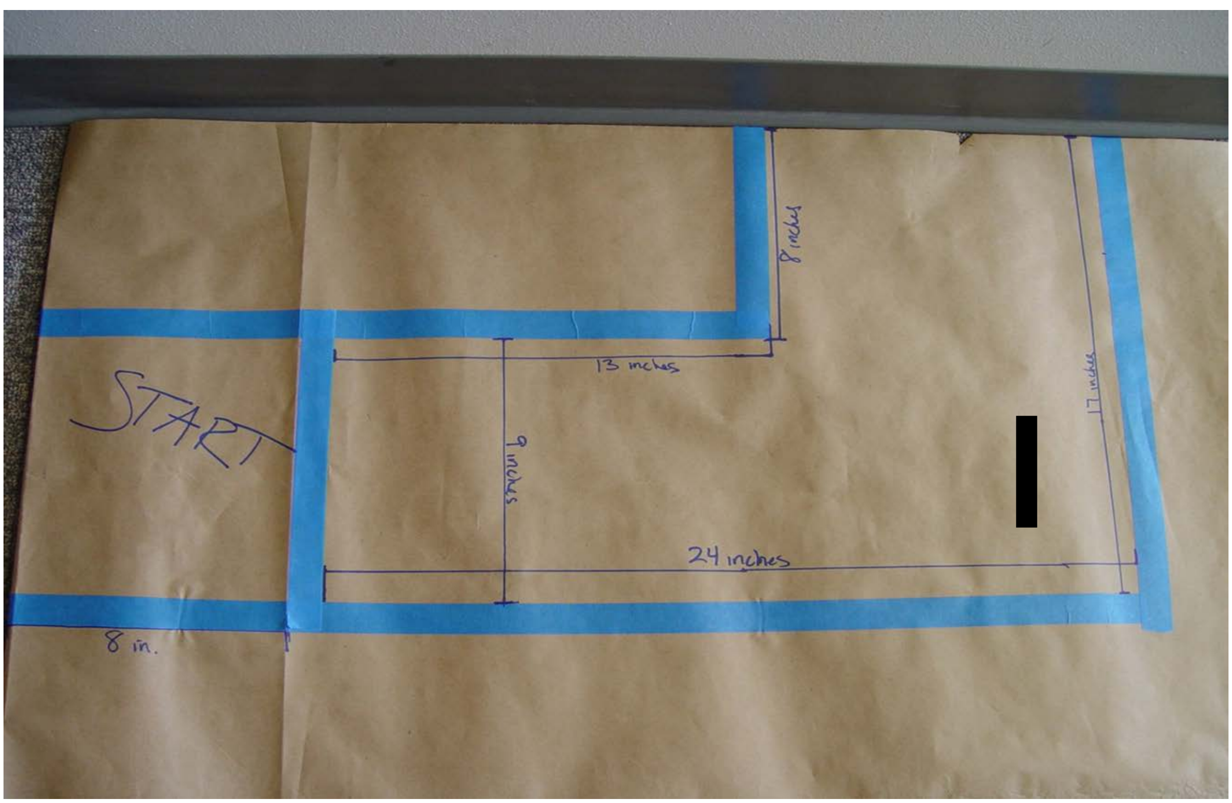
Introduction
This robotic challenge uses a challenge mat. The robot configuration must include the light sensor and the touch sensor. The obstacle listed on the challenge schematic can be a wall or any other object that will not move when struck by the robot. The participants will not be told the distance from the start box to the corner nor will they be given the distance from the corner to the obstacle. They will need to use trial-and-error to calculate the proper travel duration of the robot. For example, they might have to view how far the robot travels in one tire rotation and then estimate how many rotations it will take to cover the required distance. The youth will also have to use trial-and-error to figure out how to make the robot turn the correct arc distance so the touch sensor is facing the obstacle. They may also reference the "**Distance the Robot Will Travel Based on Wheel Size"** to estimate how many rotations or degrees it will take to successfully complete the challenge.

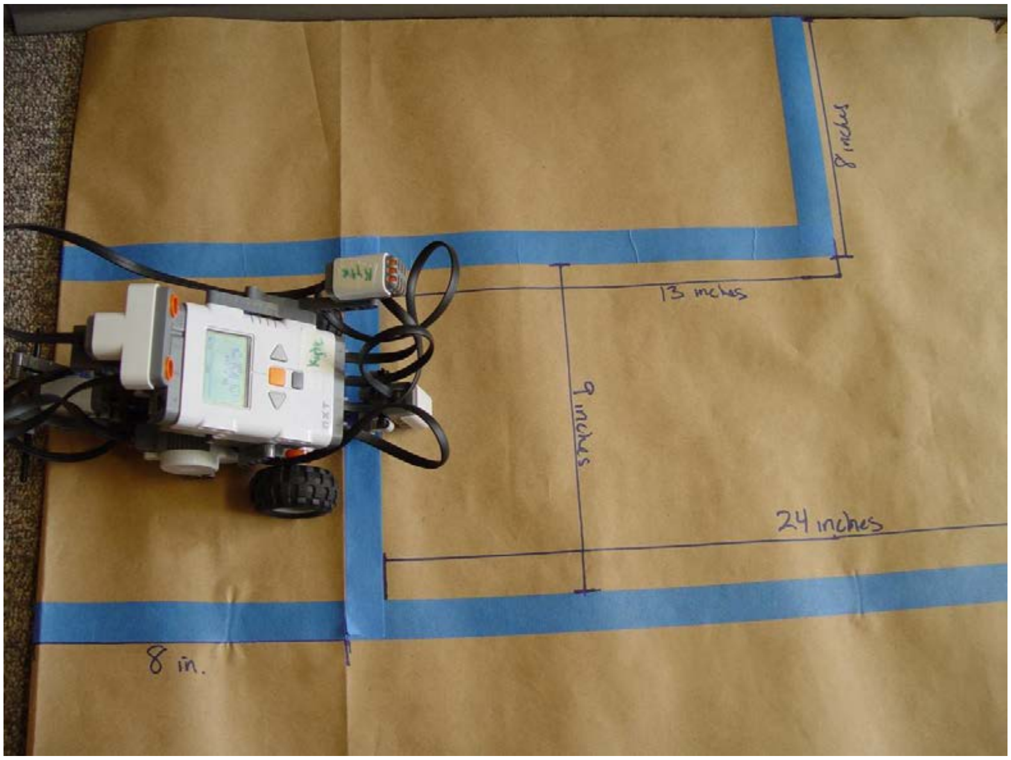
Objectives
Youth will demonstrate creativity, innovation and critical thinking skills.
Youth will increase their ability to work collaboratively with others.
Youth will be able to improve communication skills.
Youth will better understand the process of programming and evaluating robotic movements.
Youth will increase their ability to design a solution to a challenge.

Level of Difficulty ☆☆☆

Preparation and Materials
Instructor should determine teaching methodology (text instructions or pictorial programming guide) that best fits the audience.
Print appropriate student materials.
Create "Magic Touch" challenge mat using:
- Masking or painter's tape
- Black tape
- Measuring tape
- Paper or poster board (at least 40 X 20 inches in size)
- Obstacle such as a weighted box, heavy book or wall


Obstacle or wall
8
in.
13 in.
17
in.
START
9
in.
8 in.
24 in.


START
8 inches
13 inches
9 inches
17 inches
24 inches
8 in.



This picture demonstrates the position of the robot in step 1 and at the end of step 6

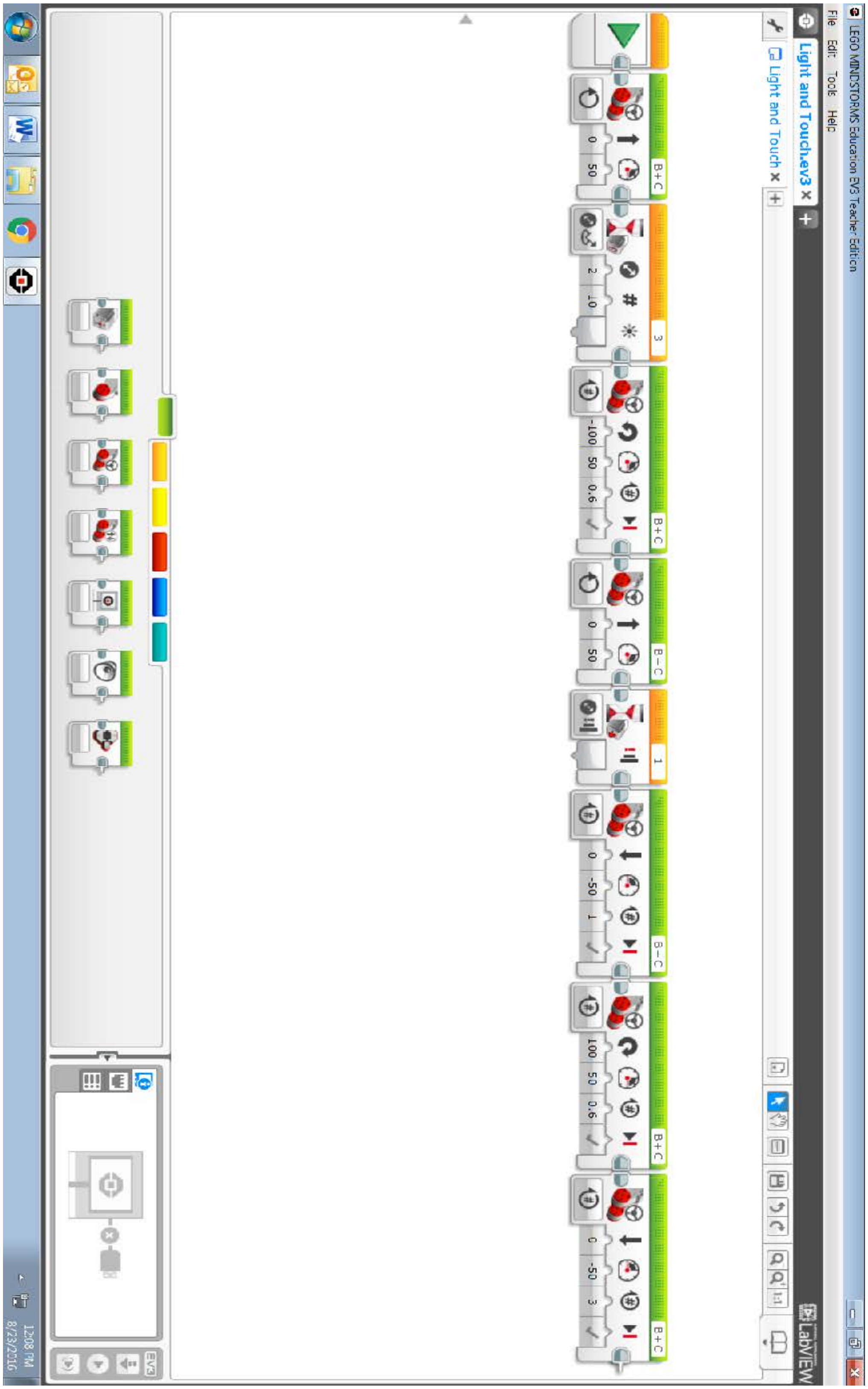
Time Required
Programming: 30-45 minutes (if participants are given text instructions only)
To run the course: 1-2 minutes

Procedure of Programming Steps
Depending on the expertise level of the participants, the instructor can give the youth the text of the steps involved in the challenge or give them the entire pictorial programming guide.

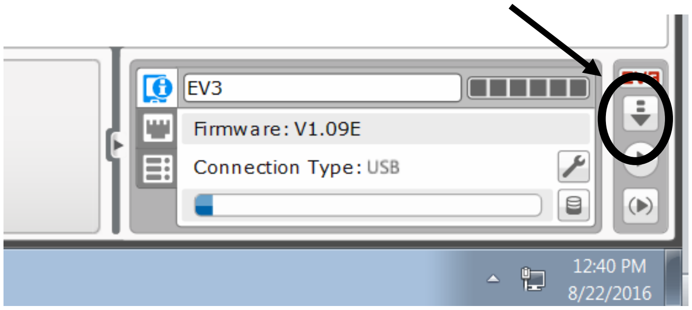
TEXT:

1. The front wheels of the robot must be completely behind the start line.
2. The robot must stay inside the lines at all times.
3. The robot uses the light sensor to move from the start area to the dark tape line.
4. The robot turns such that the touch sensor is facing the obstacle.
5. The robot touches the obstacle with the touch sensor.
6. Once the robot touches the obstacle it must return to its initial starting position (facing forward and ready to complete the course again).

COMPLETE PICTORIAL PROGRAMMING GUIDE:



A. Connect the computer and the robot using the USB cord and make sure the robot is turned on.
B. Download the program onto the robot by pressing the download button at the bottom right corner of the computer screen.



C. Disconnect the robot from the USB cord.
D. Find the program on the robot and use the dark gray button to start the program.

Discussion Questions
What difficulties did you encounter with the programming?

What did you do to overcome these difficulties?

What strategies did you use to figure out how to program the robot to turn in step 4?

Why did you need to select “on” for the move block in Step 5?

You needed to select “on” because you didn’t know how away the obstacle was that would activate the touch sensor.

What other things might use a touch sensor?

Automatic car wash

Touch screens

Instructor Guide
Challenge Title:

EV3 X Marks the Spot

Introduction

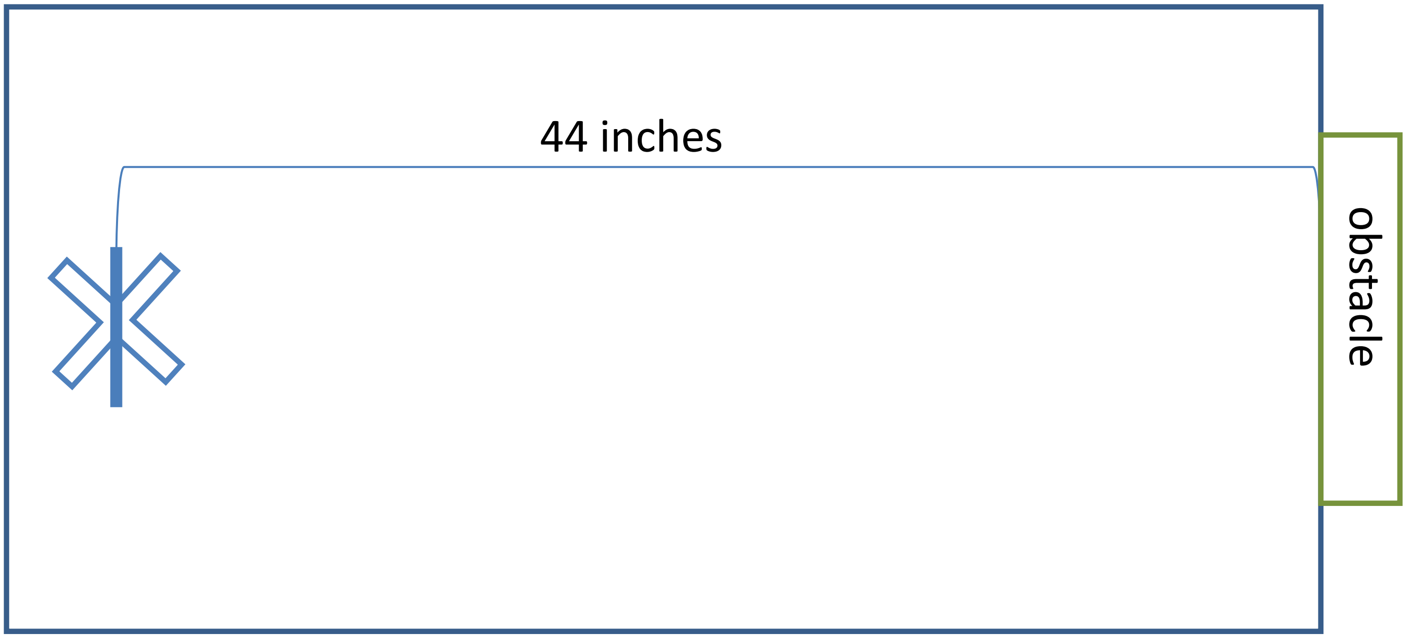
This robotic challenge uses a challenge mat. The robot configuration must include the touch sensor and the ultrasonic (distance) sensor. The obstacle listed on the challenge schematic can be a wall or any other object that will not move when struck by the robot. The participants will not be told the distance from the obstacle to the X. They will need to use trial-and-error to calculate the proper travel duration of the robot. For example, they might have to view how far the robot travels in one tire rotation and then estimate how many rotations it will take to cover the required distance. The youth will also have to use trial-and-error to figure out how to make the robot turn the correct arc distance so the touch sensor is facing the obstacle after the robot spins on the X in step 6. They may also reference the "**Distance the Robot Will Travel Based on Wheel Size"** activity to estimate how many rotations or degrees it will take to successfully complete the challenge.

Objectives
Youth will demonstrate creativity, innovation and critical thinking skills.
Youth will increase their ability to work collaboratively with others.
Youth will be able to improve communication skills.
Youth will better understand the process of programming and evaluating robotic movements.
Youth will increase their ability to design a solution to a challenge.

Level of Difficulty ☆☆☆

Preparation and Materials
Instructor should determine teaching methodology (text instructions or pictorial programming guide) that best fits the audience.
Print appropriate student materials.
Create "X Marks the Spot" challenge mat using:

Masking or painter's tape
Measuring tape
Paper or poster board (at least 50 X 12 inches in size)
Obstacle such as a weighted box, heavy book, or wall.


44 inches
obstacle


44 inches

Time Required

Programming: 45 minutes – 1 hour (if participants are given text instructions only).
To run the course: 2-3 minutes.

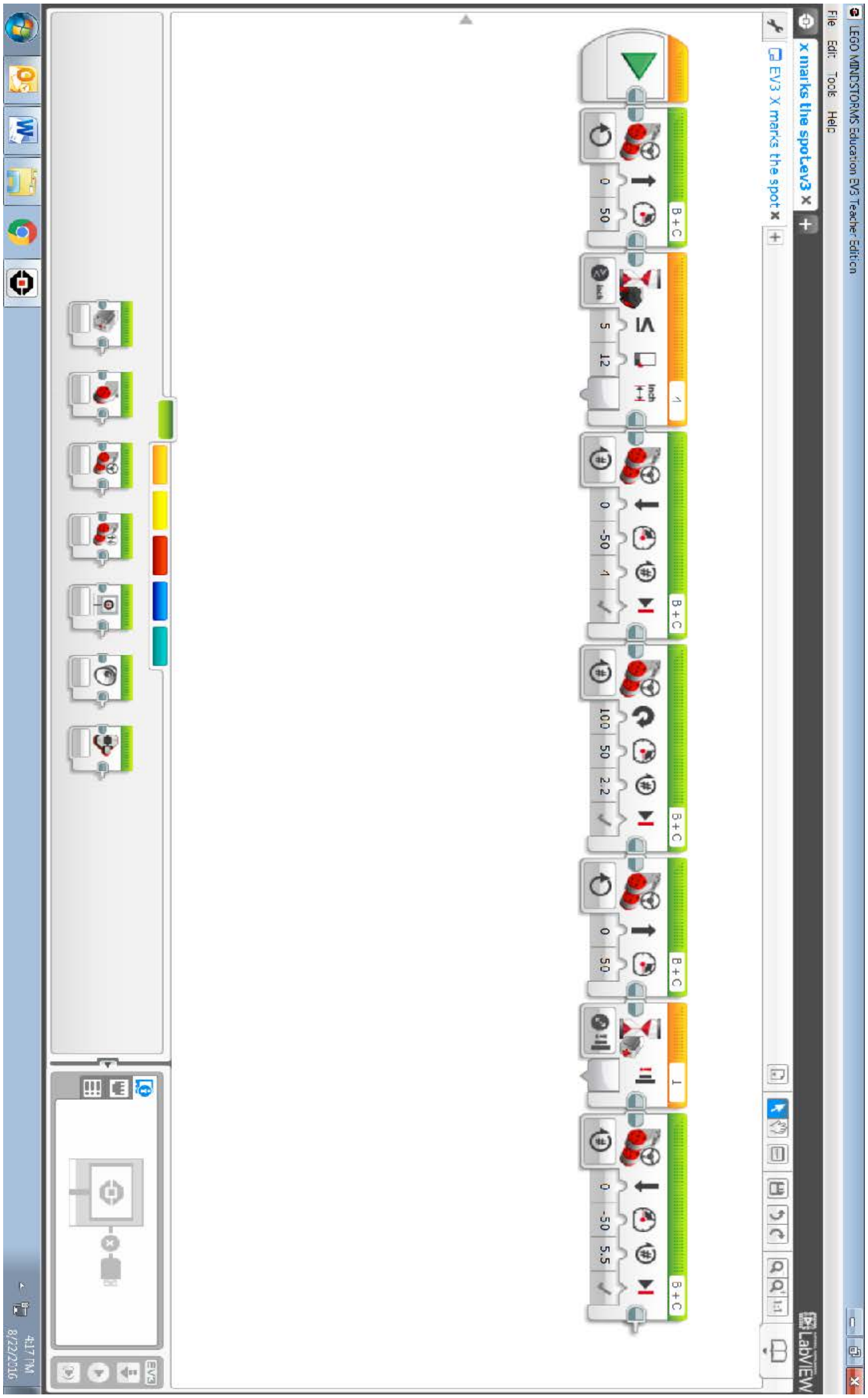
Procedure of Programming Steps

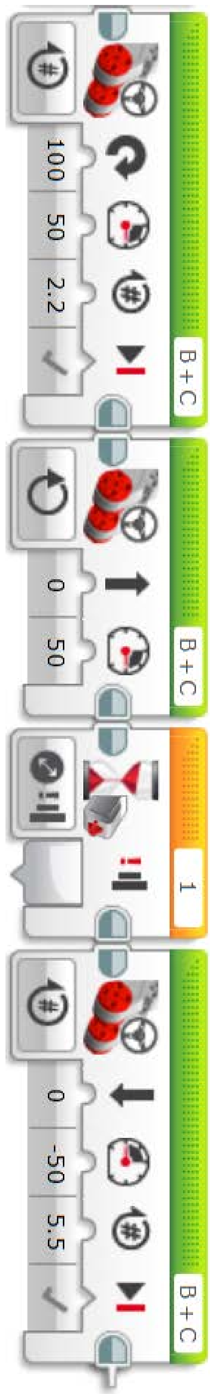
Depending on the expertise level of the participants, the instructor can give the youth the text of the steps involved in the challenge or give them the entire pictorial programming guide.

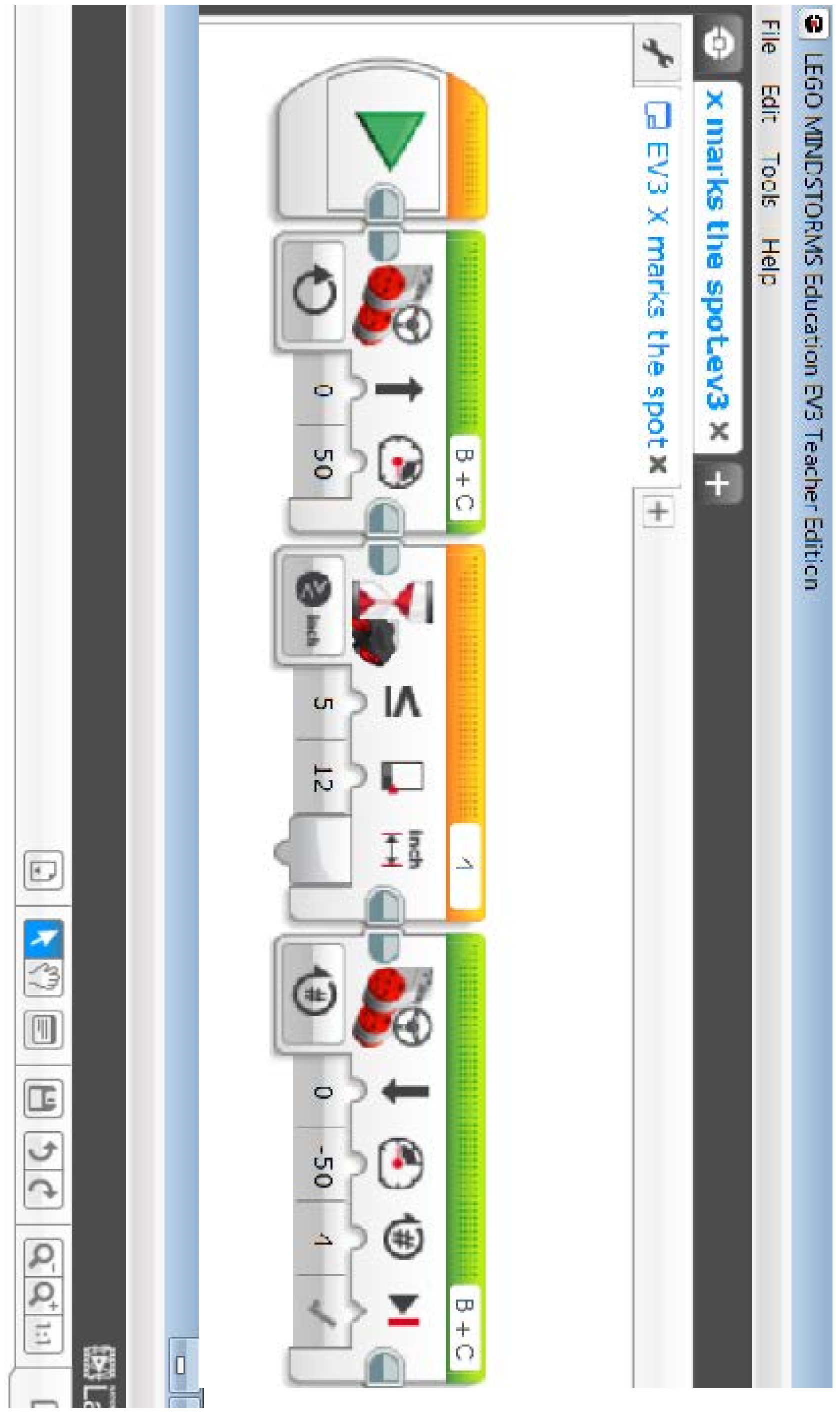
TEXT:

1. The robot begins the challenge centered on the X facing toward the obstacle (ultrasonic sensor facing obstacle).
2. The robot moves toward the obstacle at 50% power.
3. The robot uses the ultrasonic sensor to detect the obstacle at a distance of 12 inches.
4. Upon sensing the obstacle the robot moves backwards.
5. The robot stops in its original position (centered on the X as in step 1).
6. The robot spins in place one complete rotation so that the touch sensor is facing the obstacle.
7. The robot moves toward the obstacle.
8. The robot touches the obstacle with the touch sensor.
9. The robot travels back to the X and stops when centered on the X.

COMPLETE PICTORIAL PROGRAMMING GUIDE:






LEGO MINDSTORMS Education EV3 Teacher Edition
File Edit Tools Help
x marks the spot.ev3
EV3 X marks the spot

A. Connect the computer and the robot using the USB cord and make sure the robot is turned on.
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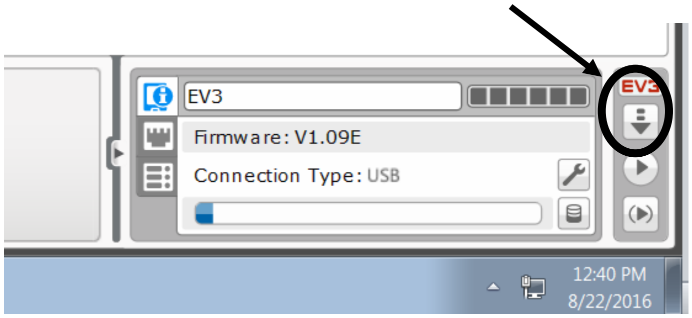

C. Disconnect the robot from the USB cord.
D. Find the program on the robot and use the dark gray button to start the program.

Discussion questions

What difficulties did you encounter with the programming?

What did you do to overcome these difficulties?

What strategies did you use to figure out the distance from the obstacle to the X?

What strategies did you use to figure out how to program the robot to turn in step 6?

Why did you need to select "on" for the move/steering block in Step 2?

You needed to select "on" because you didn't know how far away the obstacle was that would activate the ultrasonic sensor.

What other things might use a touch sensor?

Automatic car wash

Touch screens

What other things might use an ultrasonic (distance) sensor?

Bats use ultrasound for navigation.

Many motion detectors use ultrasound (burglar alarms, motion sensing lights).