Learning Coding and Math with RoboBlockly

Teaching Resource for Grade 8 Math

Harry H. Cheng

UC Davis Center for Integrated Computing and STEM Education (C-STEM)

http://c-stem.ucdavis.edu
http://roboblockly.ucdavis.edu
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University of California—Davis

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Additional Contributor(s):

Kayce Mastrup
How to Use RoboBlockly Activities in your Classroom

What is the purpose of RoboBlockly?

In RoboBlockly, students program a robot using a user-friendly drag-and-drop method. Students will complete basic problem solving to move a robot or multiple robots.

RoboBlockly is built to allow students to work at their own pace, but in general each problem should take approximately 5 minutes to complete each activity. We encourage you to give students additional time if needed or make it clear that they don’t need to finish the entire set of activities during one class session.

General Computer Usage Requirements

Technology Requirements: Any modern browser on computers, laptops, tables, or smartphones with any type of operating system.

It is important to know that every browser functions differently. We encourage you to test RoboBlockly on the computers you will have students using before implementation. Please test out the following: audio and video streaming quality, default browser specific mechanisms for saving blocks and saving Ch code, etc. all so you are better able to support your students. Make sure that pop ups have been enabled on all computers.

You may wish to provide headphones or ask students to bring headphones to allow students to independently watch tutorial videos.

Prepare yourself

Go through the activities yourself so that you are familiar with what your students will be experiencing. The Teacher Resource Packet contains all the activities and solutions for the pathway. Please note that the activities build on previous activities in each pathways such that students may need to complete some or all activities prior to the activity selected.

1) Determine the purpose for students using RoboBlockly:
   - To support student learning in Math,
   - To support student learning in Computer Programming,
   - To support student learning in Robotics.

2) Based on your purpose, determine what additional resources your students will need for instruction. We do not recommend using RoboBlockly to introduce a mathematical concept but to rather use it for skill building or as a culminating performance task.
   **Use as skill building:** We recommend that you provide your students with a worksheet that includes important related definitions, work space, leading questions, etc. and encourage your students to refer to their class notes which cover these topics.
   **Use as a culminating performance task:** Carefully select which activity directly relates to the content you have taught, making note that the previous activities may be necessary to complete to build prior knowledge.

Prepare your students

Help students get excited about RoboBlockly by inspiring students and discussing how computer science impacts every part of our lives. As a class, list things that use code in everyday life, or discuss different ways technology impacts our lives etc.

When using RoboBlockly in class, first demonstrate to students how to navigate and use the RoboBlockly website. There are five Video Tutorials, along with a self-guided interactive non-video tutorial which should be used to help familiarize your students with the different functionalities of RoboBlockly. Helping students understand the functionality of RoboBlockly and which elements can be manipulated in which manners is very important to ensuring your students have full access to the content.
Pre-Requisite Skills

Math
We are currently developing a comprehensive wiring guide to assist you with your planning. Please refer to the Table of Contents Standard Mapping for a complete list of Common Core Grade 8 Math Standards addressed in the RoboBlockly activities.

Computer
- Basic computer skills:
  - Drag and drop using a mouse
  - Key boarding
  - Navigating a web browser
  - Zoom In/Out in a browser
  - Disabling or enabling pop-up windows
  - Adjusting volume for videos

Extension
Using hardwired robots, Linkbot Controller, RoboSim or Robot Controller to execute programs built in RoboBlockly.

All can be downloaded from the UC Davis C-STEM Center’s webpage: http://c-stem.ucdavis.edu/downloads/
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<td>8.EE.5 8.EE.7</td>
<td>setSpeed driveTime turn</td>
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<td></td>
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<td>trace</td>
</tr>
<tr>
<td></td>
<td>8.G.1b</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>setSpeed</td>
</tr>
<tr>
<td></td>
<td>8.EE.7</td>
<td>driveDistanceNB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>driveDistance</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
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<td></td>
<td></td>
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</tr>
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</tr>
<tr>
<td>Parabolas</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Standard Mapping

<table>
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<tr>
<th>Common Core State Standards for Mathematics – Grade 8</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.F.3 Interpret the equation ( y = mx + b ) as defining a linear function, whose graph is a straight line; give example so functions that are not linear.</td>
<td>13</td>
</tr>
<tr>
<td>8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of a graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.</td>
<td>6, 7, 12</td>
</tr>
<tr>
<td>8.EE.7 Solve linear equations in one variable.</td>
<td>6, 7, 12</td>
</tr>
<tr>
<td>8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>8.EE.8 Analyze and solve pairs of simultaneous linear equations.</td>
<td>5</td>
</tr>
<tr>
<td>8.EE.8a Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.</td>
<td>5</td>
</tr>
<tr>
<td>8.EE.8b Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, ( 3x+2y=5 ) and ( 3x+2y=6 ) have no solution because ( 3x+2y ) cannot simultaneously be 5 and 6</td>
<td>5</td>
</tr>
<tr>
<td>8.G.1 Verify experimentally the properties of rotations, reflections, and translations:</td>
<td>8, 9, 10, 11</td>
</tr>
<tr>
<td>8.G.1a Lines are taken to lines, and line segments to line segments of the same length.</td>
<td>8, 9, 10, 11</td>
</tr>
<tr>
<td>Common Core State Standards for Mathematics – Grade 8</td>
<td>Activities</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>8.G.1b</strong> Angles are taken to angles of the same measure.</td>
<td>10, 11</td>
</tr>
<tr>
<td><strong>8.G.3</strong> Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.</td>
<td>10, 11</td>
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<tr>
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<td>X X</td>
</tr>
<tr>
<td>Section 9.1 Move a Two-Wheel Robot with the Specified Distance 9.1.1</td>
<td>X X X</td>
</tr>
<tr>
<td>Section 9.2 Move A Two-Wheel Robot with the Specified Time</td>
<td>X</td>
</tr>
<tr>
<td>Section 10.1 Move a Linkbot-I in a Coordinate System</td>
<td>X X X X X X X X X</td>
</tr>
<tr>
<td>Section 10.3 Trace the Positions of a Linkbot-I</td>
<td>X X X X</td>
</tr>
<tr>
<td>Section 12.5 Move Multiple Linkbots with Specified Distances or Joint Angles</td>
<td>X</td>
</tr>
</tbody>
</table>

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Activity #1 Graphing Linear Equations: Slope-Intercept Form

Common Core State Standards - Mathematics:
8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

Objective: Students will use a robot to graph an equation given in slope-intercept form. Students will need to make sure their graph goes through the entire coordinate plane by finding three points on the line.

RoboBlockly Student Activity:

| Initial Student Prompt | Graphing Linear Equations  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>You will use the robot to drive along the graph of a given linear equation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre-Placed Blocks</th>
<th>![Pre-Placed Blocks Image]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>trace Off = </code></td>
</tr>
</tbody>
</table>
|                   | `driveyTo(x,
|                   |   2 in, y = -12 in);` |
|                   | `trace On = ` |

| Problem Statement | Draw the line y=4x-4.  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Draw your line through the entire coordinate plane.</td>
</tr>
<tr>
<td></td>
<td>The preplaced blocks will drive the robot to the starting position.</td>
</tr>
<tr>
<td></td>
<td>Place additional blocks to drive the robot along the graph of the line across the entire coordinate plane.</td>
</tr>
<tr>
<td></td>
<td>Make sure to place at minimum of three additional points on the line.</td>
</tr>
</tbody>
</table>
Check Your Answer

Check your solution with the answer below.

Hint

None

Possible Solution in C

```
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;
robot.traceOff();
robot.drivexyTo(-2, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(7, 24, radius, trackwidth);
```
Activity #1 Graphing Linear Equations: Slope-Intercept Form

Picture of solution in RoboBlockly

Location of solution for “Load Blocks” tab in RoboBlockly
C-STEM Studio -> Teaching Resources ->TeachGrade8->RoboBlocklySolution->m1.xml

Student Mathematical Calculations
Students will graph the equation $y = 4x - 4$ in one of two ways:

*Method 1: Making a Table, students are already given (-2, -12) as a solution*

<table>
<thead>
<tr>
<th>x-value (input)</th>
<th>y = 4x - 4</th>
<th>y-value (output)</th>
<th>(x, y) Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>$y = 4(-2) - 4 = -8 - 4$</td>
<td>-12</td>
<td>(-2, -12)</td>
</tr>
<tr>
<td>0</td>
<td>$y = 4(0) - 4 = 0 - 4$</td>
<td>-4</td>
<td>(0, -4)</td>
</tr>
<tr>
<td>2</td>
<td>$y = 4(2) - 4 = 8 - 4$</td>
<td>4</td>
<td>(2, 4)</td>
</tr>
<tr>
<td>4</td>
<td>$y = 4(4) - 4 = 16 - 4$</td>
<td>12</td>
<td>(4, 12)</td>
</tr>
</tbody>
</table>

*these are only examples of solutions as students may select different x-values (inputs) which would change their y-values (outputs) however the graph will still look the same.

*Method 2: Slope & y-intercept*
In this method students would apply their previous understanding of equations in $y = mx + b$ form know that $m$ represents the slope of the line and $b$ is the y-intercept. In this problem $y = 4x - 4$ the line has a slope of 4 and goes through the y-axis at -4. Students are also given and additional point (-2, -12) on the line.

To graph using the slope and starting point (-2, -12) students will start at the point and rise up 4 spaces, then run 1 to the right. This would be an ordered pair on the line $y = 4x - 4$ (a solution to the function).

Student would continue this process across the entire coordinate grid to obtain at least three additional points that they could use to program the robot to drive across the coordinate plane.

C-STEM text alignment: Robot Programming with Linkbot for the Absolute Beginner, 5th edition

a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)

b) Section 10.3 Trace the Positions of a Linkbot-I. (trace block)
Activity #2  Graphing Linear Equations: Slope-Intercept Form

Common Core State Standards - Mathematics:
8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

Objective: Students draw two linear equations in slope-intercept form with the robot. Students will need to identify three points on each line to graph their equations.

RoboBlockly Activity:

| Initial Student Prompt | Graphing Linear Equations  
Use one robot to draw the two lines given in slope-intercept form. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Placed Blocks</td>
<td>[Image of blocks]</td>
</tr>
<tr>
<td>Problem Statement</td>
<td>Draw the lines y=2x+10 and y=3x+6. You will only use one robot to draw the two given lines. You must use at minimum of 3 points to plot each line. Each of your lines must go across the entire coordinate plane.</td>
</tr>
<tr>
<td>Check Your Answer</td>
<td>Check your solution with the answer below.</td>
</tr>
<tr>
<td>Hint</td>
<td>None.</td>
</tr>
</tbody>
</table>
Possible Solution in C:

```c
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.traceOff();
robot.drivexyTo(-11, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(7, 24, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(6, 24, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-6, -12, radius, trackwidth);
```
Activity #2 Graphing Linear Equations: Slope-Intercept Form

Picture of solution in RoboBlockly

<table>
<thead>
<tr>
<th>x-value (input)</th>
<th>y-value (output)</th>
<th>(x, y) Solution</th>
<th>x-value (input)</th>
<th>y-value (output)</th>
<th>(x, y) Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>-11</td>
<td>2(-11) + 10</td>
<td>-12 (-11, -12)</td>
<td>-5</td>
<td>3(5) + 6</td>
<td>-9 (-5, -9)</td>
</tr>
<tr>
<td>0</td>
<td>4(0) + 10</td>
<td>10 (0, 10)</td>
<td>0</td>
<td>3(0) + 6</td>
<td>6 (0, 6)</td>
</tr>
<tr>
<td>3</td>
<td>2(3) + 10</td>
<td>16 (3, 16)</td>
<td>3</td>
<td>3(3) + 6</td>
<td>15 (3, 15)</td>
</tr>
<tr>
<td>7</td>
<td>2(7) + 10</td>
<td>24 (7, 24)</td>
<td>6</td>
<td>3(6) + 6</td>
<td>24 (7, 24)</td>
</tr>
</tbody>
</table>

These are only examples of solutions as students may select different x-values (inputs) which would change their y-values (outputs) however the graph will still look the same.

Method 2: Slope & y-intercept

In this method students would apply their previous understanding of equations in y = mx + b form know that m represents the slope of the line and b is the y-intercept. In this problem y = 2x + 10 the line has a slope of 2 and goes through the y-axis at 10. Students are also given and additional point (-11, -12) on the line.
To graph using the slope and starting point (-11, -12) students will start at the point and rise up 2 spaces, then run 1 to the right. This would be an ordered pair on the line y = 2x + 10 (a solution to the function). Student would continue this process across the entire coordinate grid to obtain at least three additional points that they could use to program the robot to drive across the coordinate plane.

They would repeat the above process for the line y = 3x + 6, except they would use a slope of 3 and could start at the y-intercept of 6 to find other points/solutions on the line.

C-STEM text alignment: *Robot Programming with Linkbot for the Absolute Beginner, 5th edition*

- a) Section 10.1 Move a Linkbot-I in a Coordinate System (driveXYTo block)
- b) Section 10.3 Trace the Positions of a Linkbot-I. (trace block)
- c) Section 2.2 Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #3 Graphing Linear Equations: Horizontal and Vertical Lines

Common Core State Standards - Mathematics:
8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms

Objective: Students will graph a horizontal and vertical line using a robot.

RoboBlockly Activity:

| Initial Student Prompt | Graphing Linear Equations  
Use on robot to draw a horizontal and vertical line. |
|------------------------|--------------------------------------------------|
| Pre-Placed Blocks | -trace Off = 0;
-drivexyTo(x, -12 in., y 18 in.);
-trace On = (); |
| Problem Statement | Draw the line x = 6 and y = 18. You will only use one robot to draw the two given lines. Each of your lines must go across the entire coordinate plane. |
| Check Your Answer | Check your solution with the answer below. |
| Hint | None. |
Possible Solution in C

```c
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;

robot.traceOff();
robot.drivexyTo(-12, 18, radius, trackwidth1);
robot.traceOn();
robot.drivexyTo(24, 18, radius, trackwidth1);
robot.traceOff();
robot.drivexyTo(6, 24, radius, trackwidth1);
robot.traceOn();
robot.drivexyTo(6, -18, radius, trackwidth1);
```
Activity #3 Graphing Linear Equations: Horizontal & Vertical Lines

Picture of solution in RoboBlockly

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m3.xml

Student Mathematical Calculations
To graph the line $y = 18$ students need to understand that lines in this form are horizontal lines that have a constant value. Students would then graph a line through the $y$-axis at 18, where every value of $x$ results in $y = 18$.

The same thought process applies to the line $x = 6$. Students would need to understand that line in this form are vertical lines that have a constant value. Students would then graph a line through the $x$-axis at 6, where every value of $y$ results in $x = 6$.

C-STEM text alignment: Robot Programming with Linkbot for the Absolute Beginner, 5th edition
a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)
b) Section 10.3 Trace the Positions of a Linkbot-I. (trace block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
### Activity #4 Graphing Linear Equations: Parallel & Perpendicular Lines

#### Common Core State Standards - Mathematics:

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

#### Objective:
Students will graph a linear equation given two points on the line. Students will then need to calculate the slope of the first line to graph two additional lines: one that is parallel through a given point and one that perpendicular through a given point.

#### RoboBlockly Activity:

| **Initial Student Prompt** | Graphing Linear Equations  
You will use 3 robots to graph linear equations.  
You will need to add 2 additional robots for this problem.  
Each robot will have its own color block for coding. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Placed Blocks</strong></td>
<td><img src="image" alt="Pre-Placed Blocks" /></td>
</tr>
</tbody>
</table>
| **Problem Statement**      | Add two more robots.  
Have robot 1 draw a line that goes through (2, 7) and (12, 12).  
Have robot 2 draw a line parallel to first one through the point (7, 0).  
Have robot 3 draw a line perpendicular to robot 1 and robot 2 through the point (7, 0).  |
<p>| <strong>Check Your Answer</strong>      | <img src="image" alt="Check Your Answer" /> |</p>
<table>
<thead>
<tr>
<th><strong>Hint</strong></th>
<th>None.</th>
</tr>
</thead>
</table>
| **Possible Solution in C#** | ```
#include <linkbot.h>
CLinkbotI robot1;
double radius1 = 1.75;
double trackwidth1 = 3.69;
CLinkbotI robot2;
double radius2 = 1.75;
double trackwidth2 = 3.69;
CLinkbotI robot3;
double radius3 = 1.75;
double trackwidth3 = 3.69;

robot1.traceOff();
robot1.drivexyTo(-12, 0, radius1, trackwidth1);
robot1.traceOn();
robot1.drivexyTo(24, 18, radius1, trackwidth1);
robot2.traceOff();
robot2.drivexyTo(-12, -9.5, radius2, trackwidth2);
robot2.traceOn();
robot2.drivexyTo(24, 8.5, radius2, trackwidth2);
robot3.traceOff();
robot3.drivexyTo(-5, 24, radius3, trackwidth3);
robot3.traceOn();
robot3.drivexyTo(13, -12, radius3, trackwidth3);
``` |
Activity #4 Graphing Linear Equations: Parallel & Perpendicular Lines

Student Mathematical Calculations
First students need to add two additional robots by clicking the “add robot” button below the grid.

Robot 1: Graph a line through (2, 7) and (12, 12)
Students will graph this line and then need to find the slope/rate of change by either using the slope formula or slope triangle.

Using the slope formula: 
\[ m = \frac{y_1 - y_2}{x_1 - x_2} = \frac{7 - 12}{2 - 12} = \frac{-5}{-10} = \frac{1}{2} \]

Now that students have the slope they can program robot 2 and robot 3 to graph parallel and perpendicular lines.

Robot 2 Parallel to the first line through (7, 0) & Robot 3 Perpendicular to the first line through (7, 0)
Students can use the relationship between the slopes of parallel and perpendicular lines to find additional points to graph the lines.

Parallel lines have the same slope where, perpendicular lines have opposite reciprocal slopes.

For robot 2, they will start at the point (7, 0) and use the same slope as robot 1. They will rise up 1 and run to the right 2. They will complete this process resulting in the following possible points: (8, 2) (9, 4) (10, 6)…they could also fall 1 and run left 2 (6, -2) (5, -4)…

For robot 3, they will start at the point (7, 0) and use opposite reciprocal slope of robot 1, so instead of \( \frac{1}{2} \) they will use a slope of -2. They will fall 2 and run right 1, resulting in the following possible points: (5, 1), (3, 2) (1, 3)…they could also rise 2 and run left 1 (9, -1) (11, -2)…

C-STEM text alignment: Robot Programming with Linkbot for the Absolute Beginner, 5th edition

a) Section 10.1 Move a Linkbot-1 in a Coordinate System (drivexyTo block)
b) Section 10.3 Trace the Positions of a Linkbot-1. (trace block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
**Activity #5 Systems of Linear Equations: Graphing the Solution**

**Common Core State Standards - Mathematics:**
8.EE.8: Analyze and solve pairs of simultaneous linear equations.

8.EE.8a: Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

8.EE.8b: Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x+2y=5 and 3x+2y=6 have no solution because 3x+2y cannot simultaneously be 5 and 6.

**Objective:** Students will use any method to solve a given system of linear equations, and then have the robot plot a line from the origin to the solution to the system in the coordinate plane.

**RoboBlockly Activity:**

| Initial Student Prompt | Solving Systems of Equations  
| Use the robot to graph a line from the origin to the solution to the given system. |

<table>
<thead>
<tr>
<th>Pre-Placed Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>drive</code>yTo(x, 3, in, y, 4, in);</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Given the system of equations 5x+y=82 and 3x-y=14, draw a line from the origin to the intersection. You do not need to show the graphs for the given system.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Check Your Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check your solution with the answer below.</td>
</tr>
</tbody>
</table>

![Graph showing line from origin to solution of system of equations]
<table>
<thead>
<tr>
<th><strong>Hint</strong></th>
<th>You can rewrite the problem as $(\frac{3}{4})x + 25% \ of \ x + 7 = x$. This can be further rewritten as $0.5x + 0.25x + 7 = x$.</th>
</tr>
</thead>
</table>
| **Possible Solution in C** | ```
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.drivexyTo(12, 22, radius, trackwidth);
``` |
Activity #5  Systems of Linear Equations: Graphing the Solution

Picture of solution in RoboBlockly

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m5.xml

Student Mathematical Calculations
Students will need to solve the system of equations using strategies learning in class: by substitution, elimination or graphing.

**Solving the system by Substitution**

\[
\begin{align*}
5x + y &= 82 \\
3x - y &= 14
\end{align*}
\]

Students will need to solve one equation for \( y \).
\[ y = -5x + 82 \]

Substitute into other equation.
\[ 3x - (-5x + 82) = 14 \]
\[ 3x + 5x - 82 = 14 \]
\[ 8x - 82 = 14 \]
\[ 8x = 96 \]
\[ x = 12 \]

Plug into one of the equations to solve for \( y \).
\[ 5(12) + y = 82 \]
\[ 60 + y = 82 \]
\[ y = 22 \]

The solution is (12, 22)

**Solving the System by Elimination**

\[
\begin{align*}
5x + y &= 82 \\
3x - y &= 14
\end{align*}
\]

Since \( y \) values are opposites ADD \[
5x + y = 82 \\
+3x - y = 14
\]
\[ 8x = 96 \]
\[ x = 12 \]

Plug into one of the equations to solve for \( y \).
\[ 5(12) + y = 82 \]
\[ 60 + y = 82 \]
\[ y = 22 \]

The solution is (12, 22)

C-STEM text alignment: *Robot Programming with Linkbot for the Absolute Beginner, 5th edition*

a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #6 Unit Rate (or Slope)

Common Core State Standards - Mathematics:
8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of a graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

8.EE.7 Solve linear equations in one variable.

Objective: Students will model unit rate (or Slope) using a robot in the coordinate plane.

RoboBlockly Activity:

<table>
<thead>
<tr>
<th>Initial Student Prompt</th>
<th>Pre-Placed Blocks</th>
<th>Problem Statement</th>
<th>Check Your Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the robot to model a proportional relationship on a graph. Use driveDistance() to complete this task.</td>
<td>setSpeed()</td>
<td>Perform the following steps without using the block driveTime: Drive forward at 2 units/sec for 4 sec, turn right 90 degrees, and then drive forward at 5 units/sec for 2 sec.</td>
<td>Check your solution with the answer below.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hint</th>
<th>Check Your Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>None.</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing unit rate (or slope)](image-url)
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.setSpeed(2, radius);
robot.driveDistance(8, radius);
robot.turnRight(90, radius, trackwidth);
robot.setSpeed(5, radius);
robot.driveDistance(10, radius);
Activity #6 Unit Rate (or Slope)

Picture of solution in RoboBlockly

Location of Solution for “Load Blocks”
C-STEM Studio - Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m6.xml

Student Mathematical Calculations
Students will need to use the equation Distance = velocity * time and relate it to the problem, since they have to use the driveDistance block rather than the driveTime block. Students need to calculate the distance.

In order to have the robot drive forward at 2 units/sec for 4 sec.
Substitute known values into the equation: \( d = v \times t \) \[ d = 3 \times 2 = 8 \]

The same process applies to driving the robot forward at 5 units/sec for 2 sec.
Substitute known values into the equation: \( d = v \times t \) \[ d = 5 \times 2 = 10 \]

Students then substitute values into RoboBlockly in the appropriate blocks to complete the task.

C-STEM text alignment: Robot Programming with Linkbot for the Absolute Beginner, 5th edition

a) Section 5.4 Move a Distance for a Two-Wheel Robot. (driveDistance block)
b) Section 5.6 Turn Left and Turn Right (turn block)
c) Section 9.1 Move a Two-Wheel Robot with the Specified Distance 9.1.1 (setSpeed block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
**Activity #7 Unit Rate (or Slope)**

**Common Core State Standards - Mathematics:**
8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of a graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*

8.EE.7 Solve linear equations in one variable.

**Objective:** Students will model unit rate (or Slope) using a robot in the coordinate plane.

**RoboBlockly Activity:**

<table>
<thead>
<tr>
<th>Initial Student Prompt</th>
<th>Unit Rate (or Slope)</th>
<th>Use the robot to model a proportional relationship on a graph. Use ( \text{driveTime}(4 \text{ sec}) ); to complete this task.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Placed Blocks</strong></td>
<td></td>
<td>( \text{setSpeed}(5 \text{ in/sec}) );</td>
</tr>
<tr>
<td><strong>Problem Statement</strong></td>
<td>Perform the following steps without using \text{driveDistance}: Drive forward at 5 units/sec for 7 units, turn left 90 degrees, and then drive forward at 1 unit/sec for 5 units.</td>
<td></td>
</tr>
<tr>
<td><strong>Check Your Answer</strong></td>
<td>Check Your Answer</td>
<td><img src="image" alt="Graph" /> Check your solution with the answer below.</td>
</tr>
<tr>
<td><strong>Hint</strong></td>
<td>None.</td>
<td></td>
</tr>
<tr>
<td><strong>Possible Solution in C</strong></td>
<td>#include &lt;linkbot.h&gt;</td>
<td>\begin{verbatim}C\text{Linkbot} \text{robot;}\n\text{double} \text{ radius} = 1.75;\n\text{double} \text{ trackwidth} = 3.69;\end{verbatim}</td>
</tr>
</tbody>
</table>
robot.setSpeed(5, radius);
robot.driveTime(1.4);
robot.turnLeft(90, radius, trackwidth);
robot.setSpeed(1, radius);
robot.driveTime(5);
Activity #7 Unit Rate (or Slope)

Picture of solution in RoboBlockly

![RoboBlockly Solution](image)

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m7.xml

Student Mathematical Calculations
Students will need to use the equation Distance = velocity*time and relate it to the problem, since they have to use the driveTime block rather than the driveDistance block. Students need to calculate the driveTime.

In order to have the robot drive forward at 5 units/sec for 7 units
Substitute known values into the equation: \[ d = v \times t \]
\[ 7 = v \times 5 \]
\[ v = 1.4 \]

The same process applies to driving the robot forward at 1 units/sec for 5 units
Substitute known values into the equation: \[ d = v \times t \]
\[ 5 = v \times 1 \]
\[ v = 5 \]

Students then substitute values into RoboBlockly in the appropriate blocks to complete the task.

C-STEM text alignment: *Robot Programming with Linkbot for the Absolute Beginner, 5th edition*

a) Section 5.6 Turn Left and Turn Right (turn block)

b) Section 9.1 Move a Two-Wheel Robot with the Specified Distance 9.1.1 (setSpeed block)

c) Section 9.2 Move a Two-Wheel Robot with the Specified Time (driveTime block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #8 Geometry in the Coordinate Plane: Translating Lines

Common Core State Standards - Mathematics:
8.G.1 Verify experimentally the properties of rotations, reflections, and translations:
   8.G.1a Lines are taken to lines, and line segments to line segments of the same length.

Objective: Students will translate a linear function four times in the coordinate plane by changing the y-intercept. They will use a robot to graph the images of the graphs.

RoboBlockly Activity:

| Initial Student Prompt | Geometry: Translating lines in the coordinate plane
|                        | Use the robot to model a linear transformation using the parent function y = 1.5x. The pre-placed blocks will graph the parent function for you |
| Pre-Placed Blocks      | ![Pre-Placed Blocks](image) |
| Problem Statement      | Translate the linear function y = 1.5x four times. Twice in the positive y direction and twice in the negative y direction in increments of 3. |
| Check Your Answer      | ![Check Your Answer](image) |
| Hint                  | None. |
| Possible Solution in C | #include <linkbot.h>
|                       | CLinkbot1 robot;
|                       | double radius = 1.75;
|                       | double trackwidth = 3.69; |
robot.drivexyTo(-8, -12, radius, trackwidth);
robot.drivexyTo(16, 24, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(14, 24, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-10, -12, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(-12, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(12, 24, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(18, 24, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-6, -12, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(-4, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(20, 24, radius, trackwidth);
Activity #8  Geometry in the Coordinate Plane: Translating Lines

Student Mathematical Calculations
To translate a function students need to understand the parts of functions and how they affect the graph. In order for a student to translate the linear function $y = 1.5x$ four times, twice in the positive y direction and twice in the negative y direction in increments of 3 they need to understand that they are moving the graph up 3 units, then up again 3 units; the same process applies to moving the graph in the negative direction.

For a linear function in the form $y = mx + b$ the value of $b$ moves the graph up and down. Four translations:

**Move 1:** $y = 1.5x + 3$ moves graph up one time in positive y direction.
**Move 2:** $y = 1.5x + 6$ moves graph up two times in positive y direction.
**Move 3:** $y = 1.5x - 3$ moves graph up one time in positive y direction.
**Move 4:** $y = 1.5x - 6$ moves graph up two times in positive y direction.

To graph this RoboBlockly students will need to input two point for each line. They are given points for the parent graph $y = 1.5x$ as (-8, -12) and (16, 24). When translating graphs in the coordinate plane the following applies: If the move is up/down you can multiply the slope by the increment to find the change in x-values of all the coordinates on the line, the y-values will remain the same.

The slope is 1.5 and the increment is 3 so $1.5(3)=2$. Every x-value of will increase/decrease by 2.

<table>
<thead>
<tr>
<th>Endpoints of Move 1</th>
<th>becomes</th>
<th>becomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-8, -12)</td>
<td>(-10, -12)</td>
<td>(16, 24)</td>
</tr>
<tr>
<td>(-10, -12)</td>
<td>(-12, -12)</td>
<td>(14, 24)</td>
</tr>
</tbody>
</table>
Endpoints of Move 3 | (-8, -12) becomes (-6, -12) and (16, 24) becomes (18, 24)
Endpoints of Move 4 | (-6, -12) becomes (-4, -12) and (18, 24) becomes (20, 24)

C-STEM text alignment: *Robot Programming with Linkbot for the Absolute Beginner, 5th edition*

a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)
b) Section 10.3 Trace the Positions of a Linkbot-I (trace block)

**Extension:** Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #9 Geometry in the Coordinate Plane: Translating Lines

Common Core State Standards - Mathematics:
8.G.1 Verify experimentally the properties of rotations, reflections, and translations:
  8.G.1a Lines are taken to lines, and line segments to line segments of the same length.

Objective: Students will translate a linear function four times in the coordinate plane along the x-axis. They will use a robot to graph the images of the graphs.

RoboBlockly Activity:

| Initial Student Prompt | Geometry: Translating lines in the coordinate plane
|------------------------|--------------------------------------------------
|                        | Translating lines in the coordinate plane. Use the robot to model a linear transformation using the parent function $y = -2x + 12$. The pre-placed blocks will graph the parent function for you. |

<table>
<thead>
<tr>
<th>Pre-Placed Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>trace ( \text{Off} )</td>
</tr>
<tr>
<td>trace ( \text{On} )</td>
</tr>
<tr>
<td>drivexyTo(x, 12, in, y, -12, in);</td>
</tr>
<tr>
<td>drivexyTo(x, -6, in, y, 24, in);</td>
</tr>
</tbody>
</table>

| Problem Statement | Translate the linear function $y = -2x + 12$ four times.
|-------------------| Twice in the positive x direction and twice in the negative x direction by increments of 6. |

<table>
<thead>
<tr>
<th>Check Your Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check your solution with the answer below.</td>
</tr>
</tbody>
</table>

| Hint | None. |
Possible Solution in C

```c
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.traceOff();
robot.drivexyTo(12, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-6, 24, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(-12, 24, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(6, -12, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(0, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-12, 12, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(0, 24, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(18, -12, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(24, -12, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(6, 24, radius, trackwidth);
```
Activity #9 Geometry in the Coordinate Plane: Translating Lines

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m9.xml

Student Mathematical Calculations
To translate a function students need to understand the parts of functions and how they affect the graph. In order for a student to translate the linear function $y = -2x + 12$ four times, twice in the positive $x$ direction and twice in the negative $x$ direction in increments of 6 they need to understand that each $x$-value is changing by a positive or negative 6 depending on the direction of the move.

<table>
<thead>
<tr>
<th>Original Endpoints</th>
<th>New Endpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-6, 24) and (12, -12)</td>
<td>(-12, 24) and (6, -12)</td>
</tr>
<tr>
<td>Move left 6 units</td>
<td>Move left 12 units</td>
</tr>
<tr>
<td>(-12, 12) and (0, -12)</td>
<td>*first point we needed to change $y$-value to fit on graph if we kept adding it would have been (-18,24)</td>
</tr>
<tr>
<td>Move right 6 units</td>
<td>Move right 12 units</td>
</tr>
<tr>
<td>(0, 24) and (18, -12)</td>
<td>(6, 24) and (24, -12)</td>
</tr>
</tbody>
</table>

C-STEM text alignment: *Robot Programming with Linkbot for the Absolute Beginner, 5th edition*

a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)
b) Section 10.3 Trace the Positions of a Linkbot-I (trace block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #10 Geometry in the Coordinate Plane: Reflections

Common Core State Standards - Mathematics:
8.G.1: Verify experimentally the properties of rotations, reflections, and translations:
   8.G.1a: Lines are taken to lines, and line segments to line segments of the same length.
   8.G.1b: Angles are taken to angles of the same measure.

8.G.3: Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

Objective: Student will use the robot to graph the pre-image and image of a triangle that is reflected over the line x = 7 by applying the transformation mapping to the vertices of the shape.

RoboBlockly Activity:

<table>
<thead>
<tr>
<th>Initial Student Prompt</th>
<th>Geometry: Reflections in the coordinate plane</th>
<th>Use the robot to model congruence of two-dimensional figures through transformation – specifically reflections.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Placed Blocks</td>
<td></td>
<td><img src="image" alt="RoboBlockly Blocks" /></td>
</tr>
<tr>
<td>Problem Statement</td>
<td>Draw a triangle (pre-image) with the vertices (3, -2), (-2, 5), and (5, 8). Then draw the image of its reflection over the line x=7.</td>
<td></td>
</tr>
<tr>
<td>Check Your Answer</td>
<td>Check Your Answer</td>
<td><img src="image" alt="Check Your Answer" /></td>
</tr>
</tbody>
</table>
### Hint
None.

Possible Solution in C

```c
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.traceOff();
robot.drivexyTo(3, -2, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-2, 5, radius, trackwidth);
robot.drivexyTo(5, 8, radius, trackwidth);
robot.drivexyTo(3, -2, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(11, -2, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(16, 5, radius, trackwidth);
robot.drivexyTo(9, 8, radius, trackwidth);
robot.drivexyTo(11, -2, radius, trackwidth);
```
Activity #10 Geometry in the Coordinate Plane: Reflections

Picture of solution in RoboBlockly

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8->RoboBlocklySolution->m10.xml

Student Mathematical Calculations
When students reflect shapes over a line they need find the distance from the ordered pair to the line of reflection and add that distance to the part of the coordinate that corresponds to the line of reflection. In this case, we are reflecting over a vertical line $x = 7$, so all of the $y$-values will remain the same and all $x$-values will change.

<table>
<thead>
<tr>
<th>Pre-Image Coordinate</th>
<th>Distance from $x = 7$</th>
<th>Reflection Mapping</th>
<th>Image Coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3, -2)</td>
<td>4 units</td>
<td>(4+7, y)</td>
<td>(11, -2)</td>
</tr>
<tr>
<td>(-2, 5)</td>
<td>9 units</td>
<td>(9+7, y)</td>
<td>(16, 5)</td>
</tr>
<tr>
<td>(5, 8)</td>
<td>2 units</td>
<td>(2+7, y)</td>
<td>(9, 7)</td>
</tr>
</tbody>
</table>

C-STEM text alignment: Robot Programming with Linkbot for the Absolute Beginner, 5th edition
a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)
b) Section 10.3 Trace the Positions of a Linkbot-I (trace block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #11 Geometry in the Coordinate Plane: Reflections

Common Core State Standards - Mathematics:
8.G.1: Verify experimentally the properties of rotations, reflections, and translations:
   8.G.1a: Lines are taken to lines, and line segments to line segments of the same length.
   8.G.1b: Angles are taken to angles of the same measure.

8.G.3: Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

Objective: Student will use the robot to graph the pre-image and image of a square that is reflected over the line $x = 6$ by applying the transformation mapping to the vertices of the shape.

RoboBlockly Activity:

| Initial Student Prompt | Geometry: Reflections in the coordinate plane
|------------------------| Use the robot to model congruence of two-dimensional figures through transformation – specifically reflections. |

<table>
<thead>
<tr>
<th>Pre-Placed Blocks</th>
</tr>
</thead>
</table>

| Problem Statement | Draw a square (pre-image) with the vertices (3, -5), (-1, -2), (2, 2) and (6, -1). Then draw the image of its reflection over the line $y=6$. |

<table>
<thead>
<tr>
<th>Check Your Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hint</strong></td>
</tr>
</tbody>
</table>
|**Possible Solution in Ch** | \footnotesize{\begin{verbatim}
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.traceOff();
robot.drivexyTo(3, -5, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-1, -2, radius, trackwidth);
robot.drivexyTo(2, 2, radius, trackwidth);
robot.drivexyTo(6, -1, radius, trackwidth);
robot.drivexyTo(3, -5, radius, trackwidth);
robot.traceOff();
robot.drivexyTo(3, 17, radius, trackwidth);
robot.traceOn();
robot.drivexyTo(-1, 14, radius, trackwidth);
robot.drivexyTo(2, 10, radius, trackwidth);
robot.drivexyTo(6, 13, radius, trackwidth);
robot.drivexyTo(3, 17, radius, trackwidth);
\end{verbatim}} |
Activity #11 Geometry in the Coordinate Plane: Reflections

Student Mathematical Calculations
When students reflect shapes over a line they need find the distance from the ordered pair to the line of reflection and add that distance to the part of the coordinate that corresponds to the line of reflection. In this case, we are reflecting over a horizontal line y = 6, so all of the x-values will remain the same and all y-values will change.

<table>
<thead>
<tr>
<th>Pre-Image Coordinate</th>
<th>Distance from y = 6</th>
<th>Reflection Mapping</th>
<th>Image Coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3, -5)</td>
<td>11 units</td>
<td>(x, 11+6)</td>
<td>(3, 17)</td>
</tr>
<tr>
<td>(-1, -2)</td>
<td>8 units</td>
<td>(x, 8 + 6)</td>
<td>(-1, 14)</td>
</tr>
<tr>
<td>(2, 2)</td>
<td>4 units</td>
<td>(x, 4 + 6)</td>
<td>(2, 10)</td>
</tr>
<tr>
<td>(6, -1)</td>
<td>7 units</td>
<td>(x, 7 + 6)</td>
<td>(6, 13)</td>
</tr>
</tbody>
</table>

C-STEM text alignment: *Robot Programming with Linkbot for the Absolute Beginner, 5th edition*

a) Section 10.1 Move a Linkbot-I in a Coordinate System (driveyTo block)
b) Section 10.3 Trace the Positions of a Linkbot-I (trace block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.
Activity #12 Solving Equations Related to Unit Rate & Modeling in the Coordinate Plane

Common Core State Standards - Mathematics:
8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of a graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

8.EE.7 Solve linear equations in one variable.

Objective: Students will work with two robots to have them start at different places in the coordinate plane and arrive at the location at the same time.

RoboBlockly Activity:

<table>
<thead>
<tr>
<th>Initial Student Prompt</th>
<th>Delay Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delay Seconds</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

*delaySeconds(seconds 3)* can be used to delay the program execution. Non-blocking functions that have been started will continue during this delay.

<table>
<thead>
<tr>
<th>Pre-Placed Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>setSpeed(speed 1.5 in/sec);</td>
</tr>
<tr>
<td>setSpeed(speed 3 in/sec);</td>
</tr>
<tr>
<td>driveDistanceNB(distance 20 in);</td>
</tr>
<tr>
<td>delaySeconds(seconds 5);</td>
</tr>
</tbody>
</table>

Problem Statement: Robot 1 drives at 1.5 units per second for 20 units. 5 seconds later, Robot 2 starts driving at 3 units per second. Drive Robot 2 to the location where it catches up to Robot 1.

Wrong Prompt: You did not drive Robot 2 to the right position. Please try again.

Hint: Robot 1 is modelled by \(d(t) = 1.5t\). Robot 2 is modelled by \(d(t) = 3(t-5)\). You need to solve for \(d\).

Possible Solution in C

```c
#include <linkbot.h>
CLinkbotI robot1;
double radius1 = 1.75;
CLinkbotI robot2;
double radius2 = 1.75;

robot1.setSpeed(1.5, radius1);
robot2.setSpeed(3, radius2);
robot1.driveDistanceNB(20, radius1);
robot2.delaySeconds(5);
robot2.driveDistance(15, radius2);
robot1.moveWait();
```
Activity #12 Solving Equations Related to Unit Rate & Modeling in the Coordinate Plane

Picture of solution in RoboBlockly

Problem Statement:
Robot 1 drives at 1.5 units per second for 20 units. 5 seconds later, Robot 2 starts driving at 3 units per second. Drive Robot 2 to the location where it catches up to Robot 1.

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m12.xml

Student Mathematical Calculations
Students will need to use distance = velocity * time to solve this problem. They will need to write two equations and determine when they are equal to program the robots to complete the task.

Robot 1 drives at 1.5 units per second for 20 units. 5 seconds later, Robot 2 starts driving at 3 units per second. Drive Robot 2 to the location where it catches up to Robot 1.

Students will first set up an equation for Robot 1:
For Robot 2 we know it will travel the same distance so its equation is:
We have two equations that are equal to 20, so set them equal to each other
Solving this will tell us the time it will take Robot 2 to catch Robot 1
Robot 2 will catch up to Robot 1 in 10 seconds. The question is asking what the distance will be, so we use t = 10 and plug it into d = vt, where v = 1.5, t = 10.
So Robot 2 will catch up to Robot 1 in 10 seconds at a distance of 15. Now students can program the robots.

C-STEM text alignment: Robot Programming with Linkbot for the Absolute Beginner, 5th edition
a) Section 9.1 Move a Two-Wheel Robot with the Specified Distance 9.1.1. (setSpeed block)
b) Section 12.5 Move Multiple Linkbots with Specified Distances or Joint Angles (driveDistance, driveDistanceNB blocks, delaySeconds and moveWait blocks)

Extension:
a) Have students use a hardwired robot or RoboSim to practice running their “Save Ch” blocks.
b) You can also use C-STEM Studio to access Ch Linkbot Controller with Two Vehicles Control to display distance versus time graph with two robots.
Activity #13 Graphing in the Coordinate Plane Using a Table: Parabolas

Common Core State Standards - Mathematics:
8.F.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give example so functions that are not linear.

**Objective:** Students will use an input output table to find ordered pairs that lie on the graph of the equation $y = \frac{1}{4}x^2$ over a specified domain and then need to determine if the graph is linear, why or why not?

**RoboBlockly Activity:**

<table>
<thead>
<tr>
<th>Initial Student Prompt</th>
<th>Drawing Parabolas. A Parabola is a U-shaped curve, containing specific properties. In this problem, you will be modeling a parabola by drawing incremental points.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Placed Blocks</td>
<td>![drivexyTo(x, 1, y, 0.25 in)]</td>
</tr>
<tr>
<td>Problem Statement</td>
<td>Draw $y = \frac{1}{4}x^2$. The domain is ${x : 0 &lt; x &lt; 10}$ by driving the robot to points on the parabola. The x coordinates should be separated by 1 unit intervals (see provided domain set).</td>
</tr>
<tr>
<td>Wrong Prompt</td>
<td>You did not draw the parabola according to the instructions. Please try again.</td>
</tr>
<tr>
<td>Hint</td>
<td>You need to solve the y-coordinate of the points by using the equation of the parabola by making a table and substituting the values of $x = 1, 2, 3, 4, 5, 6, 7, 8, 9$ into the given equation and solving for $y$.</td>
</tr>
</tbody>
</table>
| Possible Solution in Ch | ```c
#include <linkbot.h>
CLinkbotI robot;
double radius = 1.75;
double trackwidth = 3.69;

robot.driveXYTo(1, 0.25, radius, trackwidth);
robot.driveXYTo(2, 1, radius, trackwidth);
robot.driveXYTo(3, 2.25, radius, trackwidth);
robot.driveXYTo(4, 4, radius, trackwidth);
robot.driveXYTo(5, 6.25, radius, trackwidth);
robot.driveXYTo(6, 9, radius, trackwidth);
robot.driveXYTo(7, 12.25, radius, trackwidth);
robot.driveXYTo(8, 16, radius, trackwidth);
robot.driveXYTo(9, 20.25, radius, trackwidth);
``` |
Activity #13 Graphing in the Coordinate Plane Using a Table: Parabolas

Picture of solution in RoboBlockly

Location of Solution for “Load Blocks”
C-STEM Studio -> Teaching Resources -> TeachGrade8 -> RoboBlocklySolution -> m13.xml

Student Mathematical Calculations
Students will make a table to calculate the values needed to graph the parabola:

<table>
<thead>
<tr>
<th>x-value</th>
<th>( y = \frac{1}{4}x^2 )</th>
<th>y-value</th>
<th>(x, y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(1/4)(1)^2</td>
<td>0.25</td>
<td>(1, 0.25)</td>
</tr>
<tr>
<td>2</td>
<td>(1/4)(2)^2</td>
<td>1</td>
<td>(2, 1)</td>
</tr>
<tr>
<td>3</td>
<td>(1/4)(3)^2</td>
<td>2.25</td>
<td>(3, 2.25)</td>
</tr>
<tr>
<td>4</td>
<td>(1/4)(4)^2</td>
<td>4</td>
<td>(4, 4)</td>
</tr>
<tr>
<td>5</td>
<td>(1/4)(5)^2</td>
<td>6.25</td>
<td>(5, 6.25)</td>
</tr>
<tr>
<td>6</td>
<td>(1/4)(6)^2</td>
<td>9</td>
<td>(6, 9)</td>
</tr>
<tr>
<td>7</td>
<td>(1/4)(7)^2</td>
<td>12.25</td>
<td>(7, 12.25)</td>
</tr>
<tr>
<td>8</td>
<td>(1/4)(8)^2</td>
<td>16</td>
<td>(8, 16)</td>
</tr>
<tr>
<td>9</td>
<td>(1/4)(9)^2</td>
<td>20.25</td>
<td>(9, 20.25)</td>
</tr>
</tbody>
</table>

C-STEM text alignment: **Robot Programming with Linkbot for the Absolute Beginner, 5th edition**

a) Section 10.1 Move a Linkbot-I in a Coordinate System (drivexyTo block)

Extension: Connect Linkbots from a Computer – have students move a hardwired robot by generating the Ch code using “Save Ch” on RoboBlockly.