

## Goals and Standards

### Implementing VEX 123 STEM Labs

STEM Labs are designed to be the online teacher's manual for VEX 123. Like a printed teacher's manual, the teacher-facing content of the STEM Labs provides all of the resources, materials, and information needed to be able to plan, teach, and assess with VEX 123. The Lab Image Slideshows are the student-facing companion to this material. For more detailed information about how to implement a STEM Lab in your classroom, see the [Implementing VEX 123 STEM Labs article](#).

### Goals



#### Students will apply

- How to use the 123 Robot to solve addition equations on a number line.



#### Students will make meaning of

- How values in an addition equation can be represented and solved using a number line.
- How to represent the operation of addition using the 123 Robot on a number line.



#### Students will be skilled at

- Waking the 123 Robot.
- Placing the 123 Robot at the starting number of the addition equation on the number line.
- Identifying how many button presses are needed to move the 123 Robot and solve for the sum.
- Pushing the button on the 123 Robot to get it to move.



### Students will know

- One space moved on the number line is equal to the addition of one.

### Objective(s)

#### Objective

1. Students will be able to describe the 1:1 relationship between one button pressed and the movement of the robot one square on the 123 Field.
2. Students will be able to count forward beginning from a given number, instead of having to begin at 1.
3. Students will be able to model and solve addition equations using a 123 Robot and a number line.

#### Activity

1. Students will describe the steps for pressing the move button on the 123 Robot once to move the robot one number on the number line, two times to move the 123 Robot two spaces on the number line, etc, in the Play Part 1 and Mid-Play Break sections.
2. In the Play sections, students will practice counting forward from the first addend in ascending order to find the sum of an equation.
3. Students will model starting their robot on the number line on the first addend, press the move button a number of times that equals the second addend in order to have the 123 Robot stop on the sum. In Play Part 1 they will practice these steps with the teacher, in Play Part 2, they will work with their group.

#### Assessment

1. Students will describe the number of button presses it takes to model an equation during the activity during the Mid-Play Break and Play Part 2.
2. Students will correctly count forward from the first addend, in ascending order, the number of spaces equal to the second addend in order to reach the sum of an addition equation on a number line during Play Part 2.
3. Students will work with their groups to solve an addition equation with the 123 Robot on a number line during Play Part 2.

### Connections to Standards

#### Additional Standards

##### Common Core State Standards (CCSS)

**CCSS.MATH.CONTENT.K.CC.A.2:** Count forward beginning from a given number within the known sequence (instead of having to begin at 1).

**How Standard is Achieved:** In Play Part 1, students will count forward beginning between numbers one to nine while coding the 123 Robot to move along the number line. Students will continue to use this process in Play Part 2 while working in small groups.

### Showcase Standards

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#### Common Core State Standards (CCSS)

**CCSS.MATH.CONTENT.1.OA.C.5:** Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).

**How Standard is Achieved:** In Lab 1, students will be able to solve an addition problem by engaging in the “counting on spaces” strategy. Students will make the connection that one press on the robot correlates to one countable movement on the number line. They will explore how addition is exemplified by ascending on the number line. In Play Part 1, students will solve an addition problem using a number line as a whole class. In Play Part 2, students will use a number line to solve differing addition problems in small groups.

### Showcase Standards

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#### Computer Science Teaching Association (CSTA)

**CSTA 1A-AP-08:** Model daily processes by creating and following algorithms (sets of step-by-step instructions) to complete tasks.

**How Standard is Achieved:** In Play Part 1 and Play Part 2, students will practice using a set of steps in order to use the robot effectively as a tool to solve an addition equation on a number line. For example, students will put the robot down on the number line, make sure the robot is facing towards the higher number, press the button the correct amount of times to reach the sum, and shake the robot to reset once it has finished the addition equation.

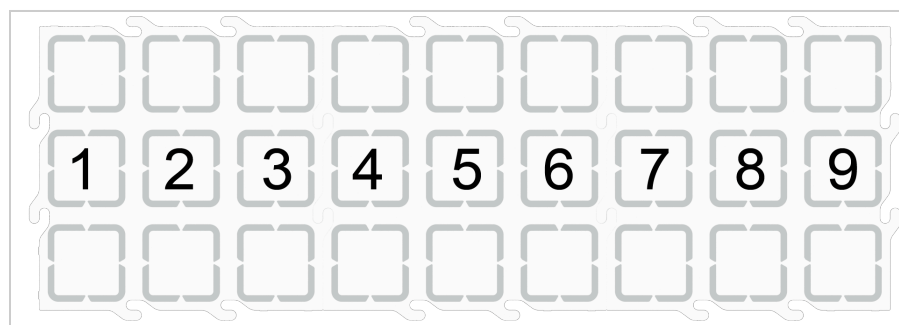
### Materials Needed

The following is a list of all the materials and teaching resources that are needed to complete the VEX 123 Lab. First listed are the materials needed for the entire Lab, including the 123 Robot. In certain Labs, links to teaching resources in a slideshow format have been included. Not all Labs will include a slideshow. These slides can help provide context and inspiration for your students. All slides are editable, and can be projected for students or used as a teacher resource.

Materials	Purpose	Recommendation
123 Robot	For students to code throughout the Lab.	1 per group
123 Field	For teachers or students to arrange into a number line.	3 tiles per number line
Dry Erase Markers	For teachers or students to write numbers on the number line.	1 per group
<b>Lab 1 Image Slideshow</b> <a href="#">Google / .pptx / .pdf</a>	Visual aids for teacher during the Lab.	1 for teacher facilitation
White board eraser	To erase the marks on the Tiles at the end of the Lab.	1 per group
<a href="#">VEX 123 PDF Printables</a> (optional)	To use as manipulatives to support student project planning and saving.	1 per group

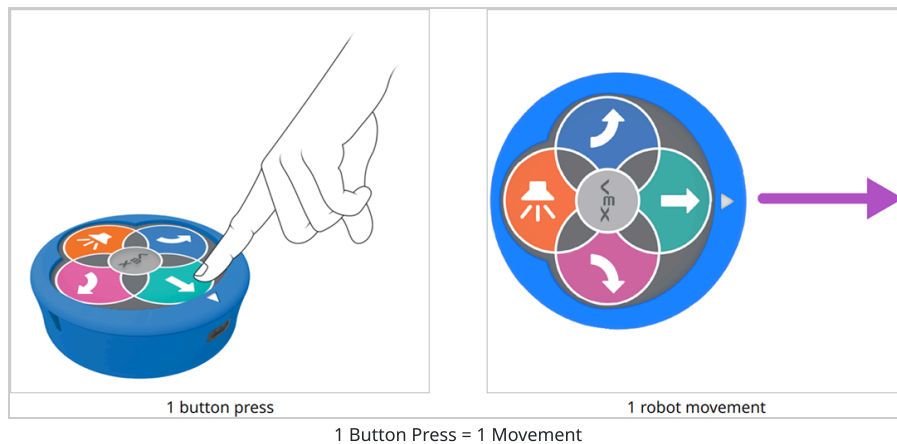
### Environment Setup

- **Print or create a list of addition equations for each group:** These will be passed out to each group during the Play Part 2 section. No equation should have an answer larger than 9 due to the spacing on the number lines. You may want to have extra in case groups finish early, this will give them additional opportunities to code the 123 Robot.
- **Create a number line with 123 Field:** Snap together groups of three 123 tiles per group in a long row. Write the numbers in the middle squares. This will be the area in which the 123 Robot travels. You may choose to write the number line on the 123 Field with dry erase markers during this set up, or have the students write the numbers on the number line during the Engage section.



Number Line with 123 Field

- **Note:** one button press moves the 123 Robot one robot length or one block on the 123 Field.



- To help students take turns and stay focused on the Lab activities, give students direction for how to share responsibilities during the Lab. For the recommended groups of two, students can take turns pressing the buttons and placing the 123 Robot, and alternate who shakes to erase the project for each new equation. For groups larger than the recommended two students, provide students with more specific roles. Examples of responsibilities for students in this Lab include:
  - Writing the numbers on the number line, or the equations for the group
  - Placing the 123 Robot on the number line
  - Pressing the move buttons on the 123 Robot
  - Pressing the start button to test the project
  - Shaking to erase the project

## Engage

Begin the lab by engaging with the students.



### Hook

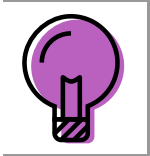
Ask the class, "Have you ever used a tool? What kind of tools have you used? Tools help us solve equations. Today we are going to use a tool to help us solve equations like a number line! Let's make a human number line." Line up students to make a human number line, where each student represents a number. Model solving an equation.



### Demonstrate



Solve the same equation using the 123 Robot and a number line made with 123 Field, and count together the number of button presses to get the 123 Robot from the first addend to the right answer.



### Leading Question

Could you solve an addition equation using the 123 Robot and a number line? Let's find out!

## Play

Allow students to explore the concepts introduced.

### Part 1

The teacher and students will work through one addition equation together using the 123 Robot to move along the number line created using 123 Field in order to find the correct answers. The emphasis will be on starting on the first addend, moving a number of spaces equal to the second addend, then stopping on the sum. The following animation shows  $2+4=6$ .

### Mid-Play Break

Review the steps for solving the equation with the 123 Robot on the number line.

- What are the steps for using the 123 Robot on the number line?
- If I want my 123 Robot to move 1 space, how many times do I need to press the move button? What if I want it to move 3 spaces?
- What direction does the 123 Robot need to face for our addition equations?
- How do I erase the code in the 123 Robot when I want to start again?

### Part 2

Have students repeat the same basic procedures to solve an addition equation with their group. The teacher can help guide students, but the students will be responsible for solving the equation on the number line.

### Alternate Coding Methods

While this Lab is written to use the buttons on the 123 Robot to touch to code, it can also be completed using the Coder or VEXcode 123. If adapting this Lab for the Coder, give each group a Coder and the Drive 1, Drive 2, and Drive

4 Coder cards to create projects that move the 123 Robot on the number line to solve equations. For more information about how to use the Coder, see the [Using the VEX 123 Coder VEX Library article](#). If modifying the Lab to use VEXcode 123, give students a tablet or computer and build projects using the [Drive for] block in VEXcode 123.

### Share

Allow students to discuss and display their learning.

### Active Share


Have the students combine their number lines together across the room for one multi-step equation to be solved together.

### Discussion Prompts

How did you decide where to place the 123 Robot on the number line to start to solve an equation?

### Launch the Engage Section

ACTS is what the teacher will do and ASKS is how the teacher will facilitate.

ACTS	ASKS
<ol style="list-style-type: none"> <li>1. Write the equation <math>1 + 4 = ?</math> at the front of the room.</li> <li>2. Have 5 students come stand at the front of the room to represent a number line. Each student should hold a number (with a sticky note or piece of paper).</li> </ol> <div>  <p>Student Number Line</p> </div> <ol style="list-style-type: none"> <li>3. Model the equation <math>1 + 4 = 5</math> with the student number line. Start at the student representing 1, then count 4 over from the first student.</li> <li>4. Draw a number line on the board.</li> <li>5. Show the students the 123 Robot with the number line.</li> </ol>	<ol style="list-style-type: none"> <li>1. What does <math>1 + 4</math> equal? (5) How do we know this?</li> <li>2. Have you ever used a tool before? A number line is a tool we can use to solve math problems.</li> <li>3. Count aloud with me as we count each classmate. We start at the student representing the first number of the equation, which is 1, then we count forward the number equal to the second number or addend of the equation, 4. We will stop on the sum, 5.</li> <li>4. This is a drawing of a number line, which is what we made with our classmates to solve the addition problem.</li> <li>5. Can we solve an addition equation using our 123 robot with a number line? Let's find out!</li> </ol>

## Engage

# 1

### Instruct

Instruct students that they are going to use the 123 Robot and a number line to solve addition equations. Let students know that first they will watch either a demonstration or an animation. Afterward, they will follow along with the teacher to practice using the 123 Robot and the number line together to solve an equation.

Once they have practiced with the teacher, they will work with their group to solve an equation on their own!

- First, demonstrate how to wake the 123 Robot as shown in this animation. For more information about how to use the 123 Robot, see the [Using the VEX 123 Robot VEX Library article](#).
- Then, demonstrate the steps or show the animation to illustrate how the 123 Robot will move on the number line to solve the equation  $2+4=6$ . Highlight the following:



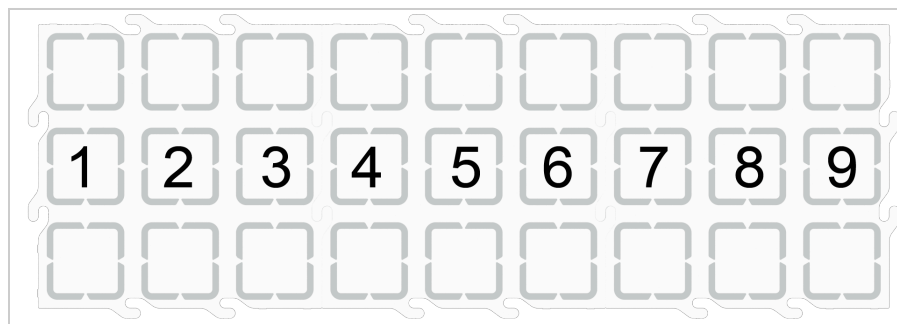
- You will press the Move button 4 times for the number being added in the equation.
- The 123 Robot is placed on the first number (2).
- Then, it will move the number of spaces equal to the second number (4).
- If done correctly, it will land on the sum (6).

## 2

### Distribute

Distribute 123 Robots to each group.

- If using shared number lines made with 123 Fields, assign each group to a number line. You may choose to set up all group number lines before the Lab to save time.



Number Line on a 123 Field

- If you would like students to practice writing their numbers, model how to write the numbers 1-9 in the middle squares of the 123 Field with Dry Erase markers. Then, have students create their number lines.

## 3

### Facilitate

Facilitate an inquiry-based discussion about how the robot moves along the number line. Ask open-ended questions directed at what the students observed in the demonstration.

- How do you think the robot knows how far to move? What do you see that makes you say that?
- Which direction does it move? Why do you think this is important?

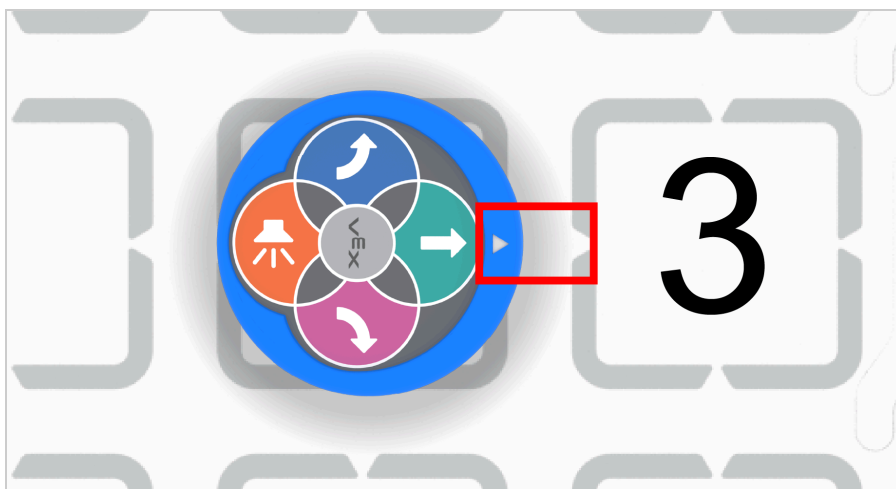
# 4

## Offer

Offer positive reinforcement for students showing good listening skills, and taking turns sharing their ideas.

### Teacher Troubleshooting

- Remind students to shake the 123 Robot after each math equation to clear the previous addition equation.
- Ensure that the 123 Robot is facing forward before starting the addition problem. The white arrow on the 123 Robot should be correctly lined up with the arrow on the 123 Field.



Aligning the 123 Robot

### Facilitation Strategies

- During the environment setup, you can set up each group's number line with 123 Fields and the dry erase markers, or have the students write in the numbers to give them more practice creating a number line and writing numbers.
- Tailor the addition equations given to the students in the classroom. Depending on their previous experience with math equations and number lines, students will have differing abilities and familiarity with addition.
- If some groups seem to catch on quicker, have them begin combining addition equations to make multi-step equations in the Play sections.

- **Use printables as manipulative to support project planning** - [See the printable resources available in the VEX Library](#), and use them with students as they are planning and building their touch projects. You could cut out the touch button symbols and have students lay them out on their desk as they build their projects, or use the color-in sheet for students to color in the sequence of button presses in their projects.

## Part 1 - Step by Step

# 1

### Instruct

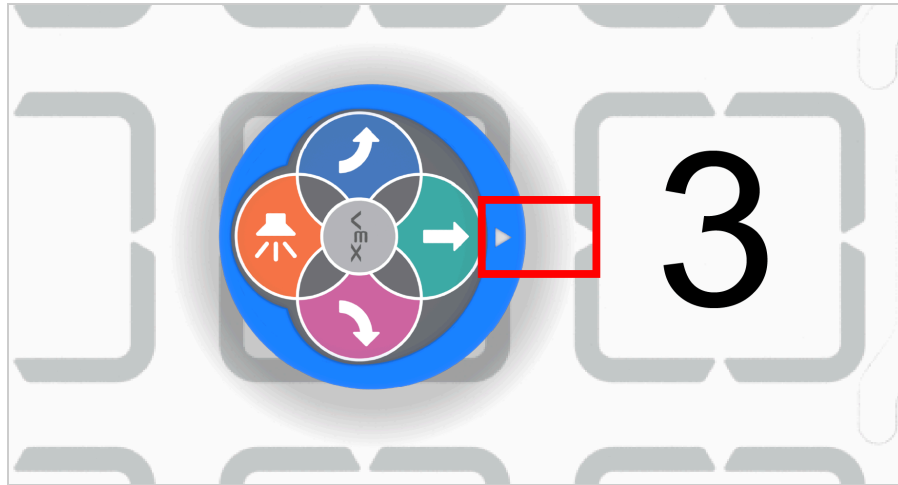
Instruct students that as a class, they are going to work together to solve a new addition equation with the 123 Robot and the number line on the 123 Field. They will work on their own number line, but they will walk through the steps together. Students will code the 123 Robot to complete the equation, as shown in the animation below for  $2+4=6$ .

# 2

### Model

Model for students the steps for coding the 123 Robot to move the correct number of spaces on the number line to solve an equation. Have students follow along with each step on their own number lines.

- Begin by writing the next addition equation on the board. The sum of the addition problem should be no more than 9.
  - For example:  $3+4=?$
- Show students how to wake the 123 Robot. To wake the 123 Robot, push the wheels along a surface until you hear the startup sound, as shown in the animation below. Turn on sound for this animation. For more detailed information about the 123 Robot, see the [Using the VEX 123 Robot VEX Library article](#).
- Demonstrate how to place the 123 Robot on the number line on the number of the first addend.
  - The 123 Robot should face the larger numbers.
  - If using the 123 Field number line, have students align the arrow on the front of the 123 Robot with the center of the number squares.



Aligning the 123 Robot

- Students should press the move button one time for each number it needs to move on the number line. This number will should match the second number (addend) of the equation.
  - In our example  $3+4=?$ . Students should place the robot on the number 3, and press the move button 4 times. When the students press "start," the 123 Robot will move to the number 7.
- Show students how to shake the 123 Robot to erase the project, as shown in the animation below.
- If students grasp this process quickly, try solving a second equation with them to practice the steps for coding the 123 Robot.

### 3

#### Facilitate

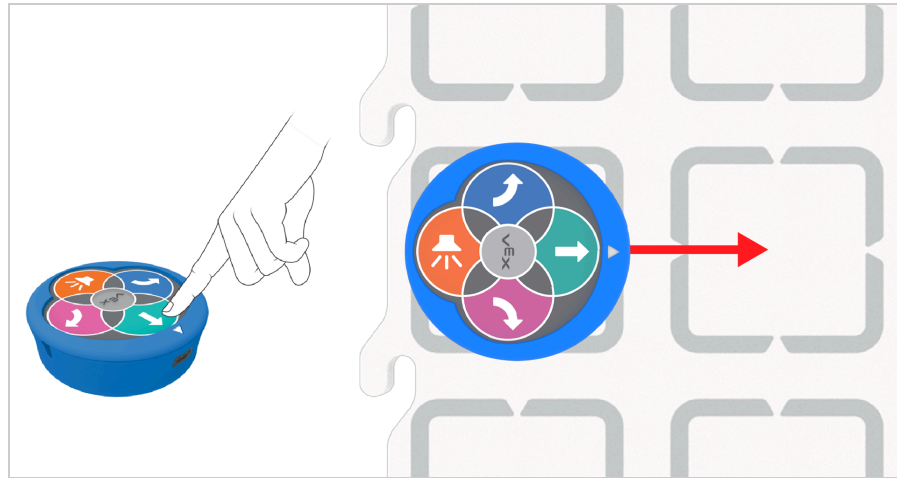
Facilitate discussions with open-ended questions that encourage students to share their observations and their thinking.

- How does your 123 Robot know how far to move?
- How does the 123 Robot know which direction to move?
- How do you know where to place the 123 Robot to solve the equation?

#### Remind

# 4

Remind students that the number of times they press the move button on the robot is the number of spaces it will move. Encourage the group to count together as they press the buttons while solving the problem.



1 Button Press = 1 Movement

- Remind students that their first try may not work as intended.
  - Did your robot find the right answer? If no, why not? What might your group need to change?
  - If your first try didn't work as planned, that is okay! All great engineers, designers and roboticists make mistakes. The key is to figure out what the mistake was, and try something different with the next try.
- Remind students to shake the 123 Robot in between tries to erase the previous try.

# 5

## Ask

Ask students how they could use their 123 Robot to help them with other math activities.

- How could you use the 123 Robot to help with counting by 5's? 10's?
- How would you have the 123 Robot count backwards? What would be different from what we are doing today?

## Mid-Play Break & Group Discussion

As soon as every group has solved the addition equation, come together for a brief conversation.

Review the steps for solving the equation with the 123 Robot on the number line.

- What are the steps for using the 123 Robot on the number line?
- If I want my 123 Robot to move 1 space, how many times do I need to press the move button? What if I want it to move 3 spaces?
- What direction does the 123 Robot need to face for our addition equations?
- How do I erase the code in the 123 Robot when I want to start again?

**Potential Student Errors:** Be aware students might be double counting. For example, if a student is adding  $3 + 5$ , they may begin at 3 and end up with an answer of 7 (3, 4, 5, 6, 7). Instead of counting on from 3 and ending with the correct answer of 8 (4, 5, 6, 7, 8).

## Part 2 - Step by Step

### 1

#### Instruct

Instruct students that they will use the process that they have learned to solve different equations with their group!

- Distribute an addition problem to each group. You may choose to distribute these one at a time or multiple problems at once for the groups. Each group will receive a different addition problem. Students will follow the same process they did in Play Part 1, to code the 123 Robot to solve the equation. The animation below shows an example using  $2+4=6$ .
- Tailor the addition equations given to the students in the classroom. Depending on their previous experience with math equations and number lines, students will have differing abilities and familiarity with addition.

### 2

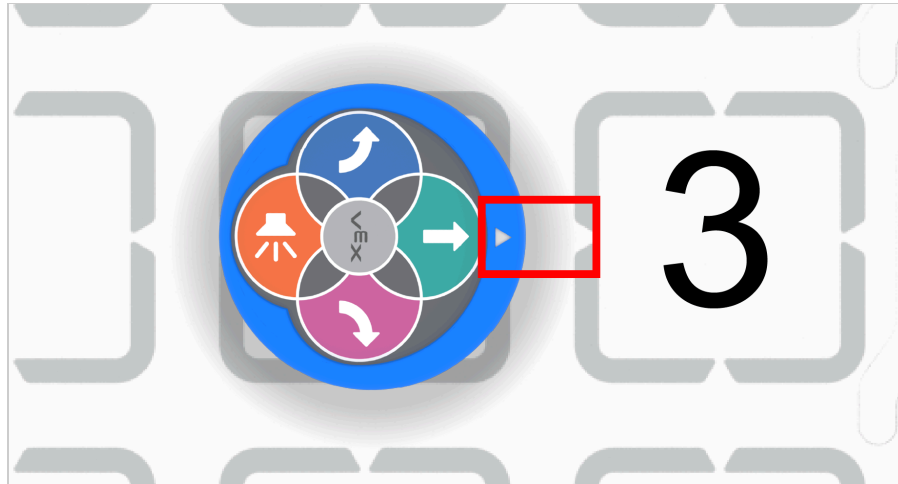
#### Model

Model setting up the equation and other steps needed to solve the new addition problem if groups need help.

Students may need reminded that:

- To wake the 123 Robot, push the wheels along a surface until you hear the startup sound, as shown in the animation below. Turn on sound for this animation.
- The number of times they press the move button on the robot is the number of spaces it will move. Encourage the group to count together as they press the buttons while solving the equation.
- The 123 Robot should be shaken to clear the memory after each try solving the addition problem.

- The 123 Robot should be lined up with the white arrow facing the arrow on the 123 Field.



Aligning the 123 Robot

- If students finish early, give them additional equations to solve. If they need an added challenge, ask them to solve multi-step problems such as  $2 + 2 + 3$ .

### 3

#### Facilitate

Facilitate by circling the room and helping groups as they need direction. Ask students to describe their thinking with questions such as:

- Where do you place the 123 Robot to start?
- How do you know how far to your 123 Robot needs to move?
- Can you show me how to place the 123 Robot on the number line?



Working with the 123 Robot

## 4

### Remind

Remind students that their first try may not work as intended.

- Did your 123 Robot find the right answer? If no, why not? What might your group need to change?
- If your first try didn't work as planned, that is okay! All great engineers, designers and roboticists make mistakes. The key is to figure out what the mistake was, and try something different with the next try.
- Encourage the groups to count out loud when pressing the buttons to ensure that they are pressing the correct amount.

## 5

### Ask

Ask students how they are working together to use the 123 Robot and the number line. Most professional engineers, roboticists work with in groups or teams. Ask students to describe how they are sharing their ideas and collaborating.

- How have you helped your group today?
- How did you share your ideas?



- Was there a time when someone in your group had a different idea than you? What did you do?

## Show Your Learning

### Active Share

1. **Facilitate** the students combining their 123 Fields to create a class number line together across the room.
  - a. Encourage each group to relabel the numbers on their own section of the new larger number line.
  - b. *Teacher Tip:* Cue the group to the impending transition by reminding them of time winding down, and what will happen next. Things like “Start wrapping up, in 5 minutes, we are going to get ready to combine our number lines.” State the expectation for the time remaining, and what they can expect moving forward.
2. **Write** a large multi-step addition problem on the whiteboard for students to see. For example:  $2+4+3+6+5=?$ 
  - a. Ask students how they would go about solving this problem on our new, bigger number line.
3. **Solve** the problem step by step with one 123 Robot.
  - a. Have the students count aloud together with each button press to reinforce the 1 : 1 correlation between the robot movements and the button presses.
  - b. Each group will be responsible for one section of the equation. If you have five groups in class, write an equation with five steps (for example:  $1 + 3 + 2 + 3 + 4 + 2$ ). Each group will add one number from the equation in turns on the same 123 Robot and class number line. This will allow them all to use the same tools and teamwork to solve a large addition problem.

### Discussion Prompts

### Digital Documentation

- Teachers can use video to record the process during Play Part 2 of the groups independently solving addition problems.

### Student-Driven Visible Thinking

- Write down student's words as they identify and describe the mathematical thinking about solving problems with the 123 Robot and the number line. Hang these quotes in the classroom to remind students of the strategies and thinking that they used, when they are doing other addition problems.

### Metacognition-Reflecting Together

- **Journal Prompts:** What is one thing that was challenging for you? One thing that you learned from this experience?
- **Process Question:** How did you decide where to place the 123 Robot on the number line to start to solve an equation?
- **Collaborating Question:** What is one way your group were good problem solvers today?