LEGO® Education
Computer Science Learning Progression

SPIKE™ Essential Grade 4

Introduction

LEGO® Education believes that students learn best through play—by actively doing, exploring, and experimenting. This approach empowers them to become creative and engaged lifelong learners, which is essential for success in their future careers and lives.

Read this Introduction to explore ways to use this learning progression and find activities that support your learners.

This learning progression organizes activities in a recommended sequence that supports students' successful learning with LEGO® Education SPIKE™ Essential. For classroom convenience, it also clusters activities that use the same model.

Following the recommended sequence ensures that students build the necessary knowledge and experience for each successive activity. However, you may also choose activities according to your students' needs and prior knowledge/experience.

Some activities are reprinted or modified from published LEGO Education sources. Others are developed especially for these learning progressions.

Each activity

- ☑ contains anticipated timing, topics, relevant standards, learning objectives, and a ready-to-use prompt.
- ☑ is labeled with one or more topics, such as Modify Programs (computer science) or Narrative Writing (ELA).
- ☑ lists the relevant standards, beginning with the most important standard in the learning.

To find what you need,

- ☑ scan the Topic(s) & Standards column or search with terms like *CSTA*, *ELA*, or *Math*.
- ☑ use the **Key** below to locate activities of different lengths and levels of instructional support.
- ☑ use the **Additional Resources** below to locate more support.

Key

1 Numbers show the recommended order in which to use activities.

Activities that use only bricks and require no hardware/software

Activities that will take approximately 20–30 mins

or Activities that will take approximately 45 or 90 mins

LESSON Longer activities with full lesson support

MORE DETAILS Links that lead to lesson details and teaching support

PROMPT Short activities to quickly expand or extend the learning

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Additional Resources (also see the LEGO® Education Community)

- ☑ *SPIKE™ App Help* Definitions and directions for using the coding blocks located in the Help section of the LEGO® Education SPIKE™ App
- ☑ *Curriculum Integration Guide* SPIKE Essential activities organized by domain Also contains a protocol for integrating activities into your curriculum
- ☑ *Coding Blocks in LEGO® Education SPIKE™ Essential Lessons*
- ☑ *Basic Coding Concepts in LEGO® Education SPIKE™ Essential Lessons*
- ☑ *Troubleshooting with LEGO® Education SPIKE™ Essential*
- ☑ *Computational Thinking in LEGO® Education SPIKE™ Essential Lessons*

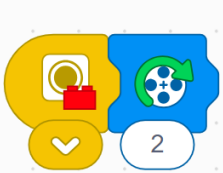
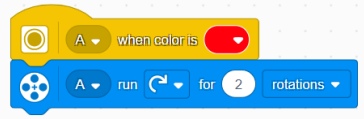
#	Activity Name	Topic(s) and Standards	Objectives Students will	Prompt
1	**Prompt** **Back-to-Back with Bricks**	**Sequences** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **Decomposition** **CSTA 1B-AP-11** Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. **Speaking and Listening** **CCSS.ELA-LITERACY.SL.4.1.B** Follow agreed-upon rules for discussions and carry out assigned roles. **CCSS.ELA-LITERACY.SL.4.1.**C Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.	• Investigate what makes a sequence by practicing creating step-by-step instructions. • Understand the importance of clear steps and directions.	Use a follow-the-steps activity to introduce students to the coding concept of sequencing. Organize pairs back-to-back and provide each partner with the same 5–6 bricks. Prompt students to take turns building and doing a Q&A together. **Say/Ask** *Build a model. Think about the steps you used to build it. Without showing the model, invite your partner to ask Yes/No questions about how to build something just like it. Remember to answer only with Yes or No. Then change roles and ask questions to build your partner's model. What happens? Was it easier to ask questions or answer them? Would this task be easier if you could give directions?* **More Details** *Basic Coding Concepts in LEGO® Education SPIKE™ Essential Lessons*

2	**PROMPT** **Meet the Motor and New Motor Blocks** 	**TESTING, COMPUTATIONAL PROBLEMS** **CSTA 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate. **TROUBLESHOOTING STRATEGIES** **CSTA 1B-CS-03** Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies.	• Follow instructions to create a program. • Compare programs using two different block languages to turn a motor. • Describe coding steps in sequence.	• Introduce students to the motor in their set as they prepare to program it. • Using the Motor tutorial, have students start the motor. Then prompt them to describe the coding steps in words to a partner. • When students have completed the motor tutorial with icon blocks, have students click on tutorial 5 Word Blocks. • Have students discuss the similarities and difference in using the icon blocks to control the motor and the word blocks. **SAY** *Connect a small motor to your hub. Follow the tutorial steps to make it move. Then tell your partner step by step what the code does. Say what happens in order.* *Next, complete the word block tutorial and program the motor using word blocks. Discuss similarities and differences between the icon blocks and word blocks with your partner.* *Discuss strategies for troubleshooting hardware and software (e.g. low battery, Bluetooth disabled, hardware not connected properly).* **MORE DETAILS** *Motor Blocks* in the Help section of the LEGO® Education SPIKE™ App, available on the web or downloaded.

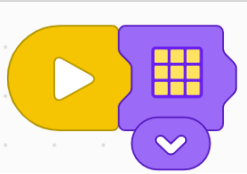
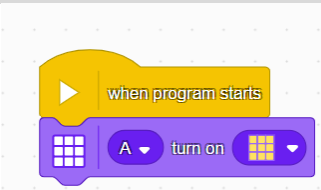
3	**PROMPT** **More with Word Blocks** 	**CONTROL** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals.	• Describe the function of different block types. • Explore different ways to program a motor using word blocks. • Use appropriate terminology when using hardware and software.	1. Have students begin lesson using word block tutorial with one motor. **SAY** *Let's learn more about word block coding. Use the Motor Blocks that we learned about to program your motor to move in different ways. To start, program the motor to change directions and speed. Then see what else you can do.* 2. *Share with students the technical names for the word blocks.* **SAY** *The word block "when program starts" is an event. When we use word blocks, events are all Hat Blocks (have the curved top so you can only stack blocks underneath). Hat Blocks are necessary to start a programming stack and are triggered when an event occurs.* *Stack Blocks are used for different commands in a program, in this case to turn a motor in a certain direction or with a specific power level. The notch on the top of the block and on the bottom of the block allow the blocks to be stacked together.* **MORE DETAILS** *Word Blocks* tutorial in the START section of the SPIKE App, available on the web or downloaded.

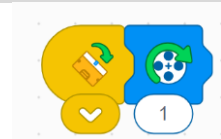
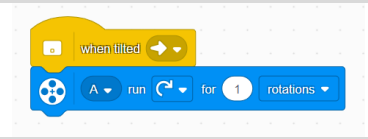
4 🕒🕒	**PROMPT** **Build a Bridge** 	**COLLABORATING AROUND COMPUTING** **CSTA 1B-AP-16** Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development. **SEQUENCES** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **DESIGN ENGINEERING** **NGSS 3-5 ETS 1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	• Build a model to meet specific criteria. • Explore programming a motor. • Use appropriate terminology when using hardware. • Test the bridge to determine how much weight it holds.	1. Have students work in pairs. 2. Explain to student that when we work with others to design, implement or review stages of a program we take on different roles. 3. Brainstorm with students different jobs that might need to be completed with you build and program using LEGO Education solutions. (e.g. driver of the computer or the person using the computer mouse to actually build the program; navigator or the person who is giving input on program design and looking for errors; parts manager; program tester, note taker, builder) Explain to students they are going to practice some roles with their partner for this activity. 4. Introduce basic design engineering tests with a quick bridge builder. 5. Provide each pair of students with 12 bricks. Prompt them to build a bridge that spans a chosen distance (e.g., road bridge over water, foot bridge over a road, train bridge). For this activity, one student will be the parts manager (selecting the LEGO brick) and one student will be the builder (putting the LEGO bricks together). 6. Then prompt them to use a common element type, such as tires or wheels, to test the bridge's strength. (for this, have one student be a note taker and one student be the "tester") **SAY/ASK** *Use the 12 bricks to make a bridge. Make sure it's high enough to fit your hands under without touching any part of the bridge. For this activity, one person will be the builder (putting the bricks together) and one person will be the parts manager (selecting the bricks to use).* **SAY/ASK** *Test the bridge by adding weight. Use an element you have a lot of, like wheels or tires. How many does the bridge hold? Keep adding to find out. For this, one person will be the tester (adding the elements to the bridge) and one person will be the note taker (collecting data)*

				Prompt students to add a motor to their bridge and program it to raise and lower the bridge like a drawbridge. As needed, refer students to The Motor tutorial in their LEGO® Education SPIKE™ App. **SAY** *Add a motor to your bridge. Program it to raise and lower the bridge. If you need help, complete The Motor tutorial in your SPIKE App. For this, one person will be the driver of the computer (the person assembling the coding blocks) and one person will be the navigator (giving design input, looking for errors)* *Review with students the different roles used during the activity. Continue to use the roles throughout the lessons and activities, encouraging students to switch roles.* **MORE DETAILS** *The Motor* tutorial in the START section of the SPIKE App, available on the web or downloaded.

5	**PROMPT** **Meet the Color Sensor** 	**TESTING, COMPUTATIONAL PROBLEMS** **CSTA 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate. **SEQUENCES** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals.	• Create a simple pseudocode to describe the steps needed in a program. • Use pseudocode to create a program to complete a task. • Use appropriate terminology when using hardware and software.	1. Introduce the Color Sensor with the tutorial in the App. Once students have the motor moving with the Color Sensor, prompt them to describe what each coding step does. 2. Introduce students to pseudocode. **SAY** *Pseudocode is the description of steps needed to complete a programming task written in everyday language. How can we describe the steps in this program using pseudocode?* When the color sensor detects red Run the motor clockwise for 2 rotations.  **SAY** *Now that we have our pseudocode, or steps needed, let's try to program the color sensor using word blocks.* Challenge students to create a program using the pseudocode in word blocks. Have students test their programs. What was similar and what is different in the programming languages? When the color sensor detects red Run the motor clockwise for 2 rotations.  **Note:** Students will need to navigate back to the home screen of the SPIKE App by clicking on the House Icon and selecting a new program using word blocks. The entire palette of programming blocks will appear. You could take the time at this point to share how blocks are organized and review the purpose of an event as well as hat blocks and stacking blocks. **MORE DETAILS** *The Color Sensor* tutorial in the START section of the LEGO® Education SPIKE™ App, available on the web or downloaded.

6	**PROMPT: More with the color Sensor** **Systems**	**COMPUTING SYSTEMS** **CSTA 1B-CS-01** Describe how internal and external parts of computing devices function to form a system. **HARDWARE AND SOFTWARE** **CSTA 1B-CS-02** Model how computer hardware and software work together as a system to accomplish tasks	• Describe how a model, using hardware and software, works as a system to accomplish a task.	1. Engage students in a discussion about a system. What are some systems they have learned about? What makes it a system? 2. Review with students how to connect and program the color sensor and a motor. 3. Have students program the color sensor to turn the motor one rotation when it detects green. 4. Ask students to describe how the hardware and software are working like a system. What parts of this system would be an input (the color sensor) and what parts of the system would be an output (the motor) and what is the role of the hub (the processor). 5. Have students modify the program to start the motor for two rotations when the color sensor detects blue. Then ask students to share with another group how the hardware and software are working together to complete the task.

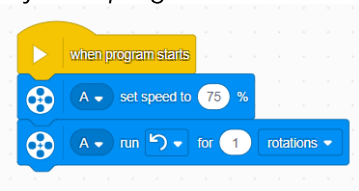
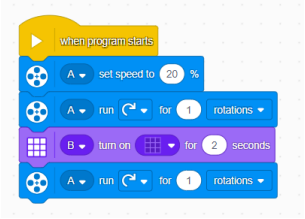
7	**PROMPT** **Meet the Light Matrix** 	**SEQUENCES** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **TESTING, COMPUTATIONAL PROBLEMS** **CSTA 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate.	• Investigate the Light Matrix. • Use word blocks to create sequences using the Light Matrix. • Use appropriate terminology when using hardware and software.	1. Introduce the Light Matrix as students program it to show light patterns. Invite them to share their work. **SAY** *The SPIKE team wants to use the Light Matrix in their adventures. Plug the Light Matrix into the hub and try programming it with word blocks to make light patterns. Show your patterns to other groups.* 2. Review the term pseudocode with students (the description of steps needed to complete a programming task written in everyday language) 3. Challenge students to write pseudocode for the icon block program they created. **SAY** *Let's write a description of the steps we needed to make the light block turn on the yellow lights. Remember we call this description pseudocode.* When play is pressed The Light Block will play and turn all the lights yellow.  4. Challenge students to create a program using the pseudocode in word blocks. Have students test their programs. What was similar and what is different in the programming languages? When play is pressed The Light Block will play and turn all the lights yellow.  **Note:** Students will need to navigate back to the home screen of the SPIKE App by clicking on the House Icon and selecting a new program using word blocks. The entire palette of programming blocks will appear. You could take the time at this point to share how blocks are organized and review the purpose of an event as well as hat blocks and stacking blocks. **MORE DETAILS** *The Light Matrix* tutorial in the START section of the SPIKE App, available on the web or downloaded.

8	**PROMPT** **Meet the Gyro Sensor**	**TESTING, COMPUTATIONAL PROBLEMS** **CSTA 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate. **SEQUENCES** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals.	• Follow instructions to create a program for the Built-in Gyro sensor. Create word block sequences using sensors.	1. Have students complete the Built-In Gyro sensor tutorial found in START on the SPIKE app. 2. Review the term pseudocode with students. 3. Have students work with their partner to write the pseudocode for the icon block program in the tutorial. When the hub is tilted right Turn the motor clockwise for one rotation  4. Challenge students to create the program in word blocks using the pseudocode. When the hub is tilted right Turn the motor clockwise for one rotation  5. Have students compare the programs. What is similar and what is different. 6. Next have students connect the Light Matrix to the hub and try programming the Gyro Sensor (using word blocks) to control the Light Matrix so it creates light patterns. As needed, use gesture to clarify tilt and/or have students complete the Built-In Gyro Sensor tutorial. (note, the programming language in the Built-In Gyro Sensor tutorial used icon blocks and a motor) **SAY** *Practice using the Gyro Sensor that is built into the hub. Connect the Light Matrix to the hub. Write a program with word blocks where the Gyro Sensor makes the Light Matrix create different patterns based on movement of the hub.*

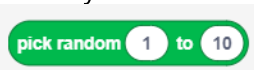
#	Activity Name	Topic(s) & Standards	Objectives Students will	Prompt
9	PROMPT **Meet the Team**	**Sequences** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **Reading Literature** **CCSS.ELA-LITERACY.RL.4.3** Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions)	• Design and program a model to represent an idea.	1. As a class, read the bios for Maria, Daniel, Sofie, and Leo. 2. Ask students to think the character traits shared in the bio for each member of the team. 3. Have pairs of students build a model that represents one team member (Maria, Daniel, Sofie or Leo). Encourage students to use the motor and/or sensors in the build. 4. Have students share their models, describing the character and the specific details shared from the text.
10	PROMPT **Integrating CS and ELA**	**Sequences** **CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **Reading Literature** **CCSS.ELA-Literacy.RL.4.3** Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions). **Narrative Writing** **CCSS.ELA-Literacy.W.4.3.B** Use dialogue and description to develop experiences and events or show the responses of characters to situations. **Design Engineering** **NGSS 3-5 ETS 1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	• Design and build a solution to the character's problem. • Describe a story character using specific details to identify a problem he or she has. • Use a solution to describe a character's response to the story situation.	1. Have student pairs identify a character from a story they're currently reading. 2. Prompt them to design and build a way for the character to solve a story problem or complete a task. Ask student include either the motor or light matrix in the solution. 3. Then invite them to explain why their solution fits with their character's likely response to the problem. **Say/Ask** *Leo and Maria love to tell stories. When they tell a story they like to think about how to help the characters. Think about the story we read. Design and build something to help one of the characters solve a problem or complete a task. Given what you know about the character, why is this a good solution for him or her?*

11	**PROMPT** **Guess My Brick-Next Level**	**NETWORKS AND THE INTERNET** **CSTA 1B-NI-05** Discuss real-world cybersecurity problems and how personal information can be protected.	• Discuss how strong passwords can help protect personal information.	Challenge students to game called "Guess My Brick!" The goal of the game is to make it hard for your opponent to guess your brick(s). • Organize pairs to create a password with LEGO bricks. • Provide bricks. • Designate a student A and a Student B • Student A chooses a brick as the password and then hides all the bricks. • Student B guesses the brick by naming its color. • Partners then take turns making more complex passwords by adding criteria, such as number of studs (bumps), special use (e.g., wheels, gears), etc. **Say/Ask** Take turns using bricks as passwords. First, choose one brick as your password. Hide it and all the bricks. Can your partner guess the color? Next, make the passwords harder. Add more things to guess, like the number of bumps on the brick. Can your partner guess? Have students share their learnings from the game and the importance of strong passwords to keep personal information safe.

	**Mini Mini-Golf**			
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
12 	**Lesson**	**Data and Analysis** **CSTA 3-5 1B-DA-7** Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea. **Energy: Speed and Collisions** **NGSS 4-PS3-1** Use evidence to construct an explanation relating the speed of an object to the energy of that object.	• Explore the basic principles of energy and their connection to an object's speed. • Identify and describe the relationship between speed and energy. • Engage effectively in a range of collaborative discussions.	Have students build and program a mini-golf model that can shoot a hole-in-one. **Say/Ask** *Sofie wants to test her mini-golf skills. Build the mini-golf model and program it to help Sofie get a hole-in-one. What does it show you about the relationship between speed and energy?* **More Details** *Mini Mini-Golf lesson* or access in the LEGO® Education SPIKE™ App.

13	**PROMPT** **Mini Mini-Golf Debugging Challenge**	**TESTING** **CSTA 1B-AP-15** Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended.	• Identify and fix errors a program to ensure it works as intended (test and debug).	1. Remind students that debugging is a method for finding and fixing mistakes in a program if it doesn't produce the desired results. 2. Have students build the mini golf model. 3. Share the following program with students to see if they can find bugs and fix the program. **SAY** *Sofie is trying to program the mini mini golf model to turn clockwise one rotation with a speed of 20%. Can you find the bugs and fix the program?*  Then challenge students with the next debugging problem. **SAY** *Sofie is trying to program the mini mini golf model to turn clockwise one rotation with a speed of 20%. Then have the light matrix display a yellow light for 2 seconds. Finally, she would like the motor to turn counterclockwise for 1 rotation. Can you find the bugs and fix the program?*  If time permits, have students create a debugging challenge for another group to solve.

14 🕒🕒	**PROMPT** **Mini Mini-Golf: More with CS and ELA**	**GIVING ATTRIBUTION** **CSTA 1B-AP-14 OBSERVE INTELLECTUAL PROPERTY RIGHTS AND GIVE APPROPRIATE ATTRIBUTION WHEN CREATING OR REMIXING PROGRAMS.** **READING LITERACY** **CCSS.ELA-LITERACY.RL.4.3** **DESCRIBE IN DEPTH A CHARACTER, SETTING, OR EVENT IN A STORY OR DRAMA, DRAWING ON SPECIFIC DETAILS IN THE TEXT (E.G., A CHARACTER'S THOUGHTS, WORDS, OR ACTIONS).**	• Create a theme based mini mini golf game. • Observe intellectual property rights and give appropriate credit.	Have students redesign the mini mini golf model to reflect a character, setting or event from a story. Ask students to specify details from the text that inspired the new model. On a small index card or piece of paper, have students write The name of their mini mini golf redesign The name of the book, author and a quote that inspired the model The model is a remix of a design from LEGO Education. Then have students participate in a gallery walk to examine and play the different mini mini golf games!

15	PROMPT **Random Numbers and Operator Blocks**	**CSTA 1B-AP-10** Create programs that include sequences, events, loops, and conditionals.	• Explore the function of an operator block • Design a program using a random number block to accomplish a task.	Explain to students that you are going to play a fun game! For this game, when you show students a blue LEGO brick, they are going to do an action. The action will be decided based on a number you randomly draw. 1. Write the numbers 1-3 on individual sticky notes or small pieces of paper. 2. With students, decide what action to assign to each number (e.g. 1 could be clapping hands 3 times, 2 could be stomping feet) 3. To play the game, show students the blue brick, then draw a random number. Show or tell students the number and have them perform the action associated with it. Make sure to place the number selected back in the pile to be selected again. 4. Play several rounds. One option is to add more actions/numbers to be selected. 5. Have students connect the color sensor and the light matrix to the hub and connect the hub to the SPIKE app in a new program. 6. Explain to students that we have a programming block in the SPIKE app that will pick a random number, similar to how we selected a random number in the game. We can find this programming block in the Operator blocks. The operator blocks have rounded edges. They will fit inside other blocks where you can insert a block with rounded edges.  Demonstrate for students how to use this block in a program. 7. Have students write a program that will turn on the light matrix for a random number between 1 and 3 seconds when it sees red.

				 8. Have students explore other ways to use the random block with the color sensor and the light matrix.

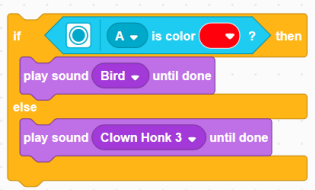
	**Bowling Fun**			
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
16 🕒🕒	**Lesson**	**Modify Programs** **CSTA 3-5 1B-AP-12** Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. **Energy: Speed and Collisions** **NGSS 4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide.	• Retrieve and modify an existing program to improve the bowling game. • Predict outcomes of the changes in energy that occur when objects collide. • Observe and describe the relationship between energy and force. •	Have students explore the energy involved when objects collide. Prompt them to build a bowling game for Daniel and program it to get strikes. (As needed, explain that a strike is when the bowler knows down *all* the pins with one ball.) **Say** *Daniel is frustrated. He wants to bowl like his friends. Build the bowling game and program it to help Daniel get a strike. Then see if you can improve the program.* **More Details** Bowling Fun lesson or access in the LEGO® Education SPIKE™ App
17 🕒	**Prompt** **Bowling Fun: More with Math** **Data and Graphing**	**Data and Analysis** **CSTA 3-5 1B-DA-06** Organize and present collected data visually to highlight relationships and support a claim. **CSTA 3-5 1B-DA-07** Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea. **Measurement and Data** **CCSS.MATH.Content.4.MD.B.4** Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve	• Carry out tests to determine how variables (e.g., type of pin, distance between ball and pins) affect the energy in a collision. • Plot fraction data to show the relationship between pins knocked down and total pins. • Create a line graph in various formats.	Have students build up to eight additional bowling pins for Daniels' game. Then have them run several bowling trials, recording their data after each roll. Prompt them to express the data (how many pins were knocked down) as a fraction of the total pins. If time allows, have students change the distance from ball to pins and run additional trials to see how it changes the data. If you wish, students may create the graph in the SPIKE App with Log and Visualize Data Over Time Blocks. **Say/Ask** *Build up to eight additional bowling pins. Run several bowling tests to see how many the game can knock*

		problems involving addition and subtraction of fractions by using information presented in line plots. For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection. **DESIGN ENGINEERING** **NGSS 3-5 ETS 1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		*over. Express the results as fractions that show the relationship between pins knocked down and total pins.* ***Then try this>*** *Put the pins at different distances from the ball and test again. What happens this time? How much does distance from the pins affect the success of the game? Show your data on a line graph. You can create it on paper or with graphing tools in the* SPIKE™ *App.* **MORE DETAILS** *Log and Visualize Data Over Time Blocks* in the HELP section of the LEGO® Education SPIKE™ App, available on the web or downloaded.
18 **PROMPT** **Bowling Fun: More with Engineering and ELA** **Accessibility**		**CSTA 1B-IC-19** Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users. **RESEARCH FOR WRITING** **CCSS.ELA-Literacy.W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic.	• Use sources and experiences to research accessibility for activities like bowling. • Modify a model to improve the accessibility for the needs or wants of a diverse user. •	Have students research (with sources, interviews, or personal experiences) accessibility for activities like bowling. Challenge students to think of a person who might like to bowl but the current model might not work for them. Have student modify the Bowling Fun model to meet the needs or wants of this user. Encourage students to use information from their research when redesigning the model. **SAY/ASK** *What are some ways that places like bowling alleys could change so that everyone could use them? Think of a person who might like to bowl but the current model will not work for them. How can you redesign the model to meet the needs or wants for this person?*

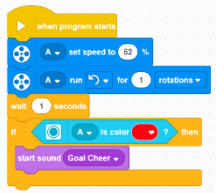
		High Stick Hockey		
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
19	LESSON	**Sequences** **CSTA 3-5 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **Energy Transfer and Transformation** **NGSS 4 PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	• Observe and describe how energy can be transferred. • Predict how energy moves from place to place. • Engage effectively in a range of collaborative discussions.	After students build the hockey game simulator, have them use it to investigate energy transfer. Prompt them to create a program to test how many goals they can score in three tries. Then encourage them to improve the program so that the game is more fun or to change the model so that it's harder to score. **Say/Ask** *Maria is excited to try the hockey game simulator. Build it and program to see how many goals you can score in three tries. How did the energy being transferred from the hockey stick to the ball impact the ball's motion? How was the energy of the ball impacted when it collided with the wall?* ***Then try this>*** *Change the program so that the game is more fun OR change the model so that it's harder to score.* **More Details** *High Stick Hockey* lesson or access in the LEGO® Education SPIKE™ App
20	PROMPTS **High Stick Hockey: More with CS**	**Creating Programs** CSTA 1B-AP-10 Create programs that include sequences, events, loops, and conditionals. **Hardware and Software** CSTA 1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks	• Investigate the differences among the functions within a motor block. • Explore the relationship between rotations and degrees in the movement of a motor.	Using the High Stick Hockey model, have students explore the function of the Motor Go to Position programming block. Ask students to describe the type of block (motor category, stack block. Then have students right click on the block and select the "help" option. Read about the features of the block. Have students predict what 0-359 position means as well as clockwise, counterclockwise and shortest path. Have students make changes to the program to observe how the motor moves when different options are selected. Have students share what they learned.

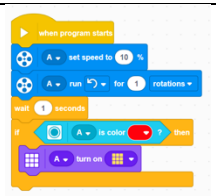
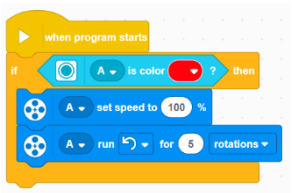
21	**PROMPTS** **High Stick Hockey: More with Engineering and Math**	**COMPUTATIONAL THINKING** **CSTA 1B-AP-12** Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features **DESIGN ENGINEERING** **NGSS 3-5 ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **MEASUREMENT AND DATA** **CCSS.Math.Content.4.MD.C.5** Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.	• Modify a model and program to generate new ways to solve a stated problem. • Test and refine the different solutions, comparing results. • Measure and identify the angles that are most effective for moving the hockey ball.	Have students add a second motor to their hockey game, and then revise the program so the hockey stick swings automatically. Prompt them try different angles for the hockey stick to see which is the most effective in moving the ball. **SAY/ASK** *Add a second motor to the hockey game. Find a way to make the hockey stick swing automatically! (You may have to revise the program.) Then experiment with swinging the stick from different angles. Measure each angle you test. Which moves the ball the most effectively?*

	**A-Maze-Ing**			
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
22 	**Lesson**	**Data Analysis** **CSTA 3-5 1B-DA-07** Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea. **Energy Transfer and Transformation** **NGSS 4 PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	• Observe and explain how interactions between two objects can impact the energy of an object. • Compare and iterate to improve the design of the solution. • Engage effectively in a range of collaborative discussions.	After students build the maze, have them program it to count the number of tilts it takes to complete it. Prompt them to try to beat Leo's record. Discuss what happens to the ball's energy as it hits the different obstacles in the maze, and how to use this understanding in their maze designs. **Say** *Leo won the maze competition. He completed the maze in only six tilts. Build and program a maze that counts the number of tilts it takes to complete. Try to beat Leo's tilts.* **More Details** *A-Maze-Ing* lesson or access in the LEGO® Education SPIKE™ App
23 	**Prompt** **A-Maze-ing: More with CS and Math**	**Data and Analysis** **CSTA 3-5 1B-DA-06** Organize and present collected data visually to highlight relationships and support a claim. **Numbers and Operations: Decimals** **CCSS.MATH.Content.4.NF.C.7** Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model. **Informative Writing** **CCSS.ELA-LITERACY.W.4.2.C** Link ideas within categories of information using words and phrases (e.g., another, for example, also, because).	• Use Bar Graph blocks to organize maze results data visually. • Use information from the Bar Graph Block to compare maze results with those of another team. • Write a paragraph comparing results, using language such as *more than, less than,* and *equal* to statements. • Use language such as *similarly, also, both* to show similarities and *instead, in contrast, but/yet* to show differences.	Using the information gathered from the Bar Graph Block, ask students to write a paragraph comparing their results to another group's results. Review and tell students to use *more than, less than,* and *equal* to statements, as well as comparative conjunctions such as *similarly* and *in contrast.* **Say** *Use the Bar Graph Blocks to compare and contrast your maze results with those of your classmates. Then write a paragraph explaining the results. Use comparison and contrast language, such as* more than, less than, *and* equal to *statements, as well as comparative conjunctions such as* similarly *and* in contrast. **More Details** *Bar Graph Blocks* in the Help section of the SPIKE App, available on the web or downloaded.
24 	**Prompt** **A-Maze-ing: More with CS**	**Modify Programs** **CSTA 3-5 1B-AP-12** Modify, remix, or incorporate portions of an existing program	• Modify an existing solution to make it meet different needs.	Allow students to try to complete another group's maze design, completing the mazes as quickly as they can. Have them add the Timer Block with a sound to their program to alert the other team when time is up. Have students identify

		into one's own work, to develop something new or add more advanced features.		the type and function of the Timer Block (event, will play blocks attached to it when timer gets above a specific value) **SAY** *Try completing another group's maze design, working to finish as quickly as possible. Before you start, add the When Timer Block to your program, so that it plays a sound when time is up.* **MORE DETAILS** *When Timer Block (Event Blocks)* in the Help section of the LEGO® Education SPIKE™ App, available on the web or downloaded.
25	**PROMPT** **Color Sensor Game** 	**SEQUENCES** **CSTA 3-5 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **COMPUTING SYSTEMS** **CSTA 3-5 1B-CS-02** Describe how internal and external parts of computing devices function to form a system.	• Follow instructions to create a program. • Use appropriate terminology when using hardware and software.	Guide students to play a guessing game. Have them connect the Color Sensor to the hub. Partner A programs the Color Sensor to play a sound if the chosen color (red in the example) is sensed and another sound if it doesn't sense that color (using the *If/Else Block*). Partner B must be told which sound signals a correct answer and which signals an incorrect answer. See the example for red.  Have partners play the game, as Partner B prompts the sensor with a color and then uses the information to guess what color Partner A has chosen. Then have pairs switch. To conclude, ask students to describe the computing system parts that work together in the game. **SAY** *Connect a motor and the Color Sensor to your hub. Take turns playing a game with your partner. One of you will program the Color Sensor to play a sound if a chosen color is sensed and another sound if it doesn't sense that color. (Try using an If/Else Block.) Tell your partner which sound is for* correct *and which is for* incorrect. *Then play the game and guess each other's color. Now think about the parts of the game. How do the hub and Light Sensor work together? How does the Light Sensor use the program you created?* **MORE DETAILS** *The Color Sensor* tutorial in the START section of the SPIKE App, available on the web or downloaded.

	**Avoid the Edge**			
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
26 Lesson	Lesson	**Computational Thinking** **CSTA 3-5 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate. **Energy** **NGSS 4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• Explore and describe energy conversion (potential and kinetic energy). • Apply and test their existing scientific knowledge of energy conversion. • Engage effectively in a range of collaborative discussions.	After students build the new game for the carnival, prompt them to use the Color Sensor to program it so the ball stops at the target. Lead discussion about what happens to the energy of the ball at different parts of the game. **Say/Ask** *Leo notices a new game at the carnival. He's eager to try it and be the first to win. What about you? Try using different bats to make the ball stop at the target! What must happen to the ball's energy for it to stop? Where does the energy go?* **More Details** *Avoid the Edge* lesson or access in the LEGO® Education SPIKE™ App

#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
27 Prompt	**Prompt** **Avoid the Edge: Debugging**	**Computational Thinking** **CSTA 1B-AP-15** Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. **Documentation** **CSTA 1B-AP-17** Describe choices made during program development using code comments, presentations, and demonstrations.	• Identify the parts of an existing program that should be modified. • Carry out tests to identify where a program can be modified.	Provide code samples for practice debugging. Ask students to debug each code. See provided examples, explanations, fixes below or make your own. Show students how to add a comment in the program by right clicking in the programming space and selecting "add comment". Students can use the comment feature to add a note regarding the parts of the program that need to be fixed.  **Example** *(Motor and sensor can't be plugged into the same port. Change one of the ports.)*

				 **Example** *(There's no Light Sensor in the model. Add a Light Sensor.)*  **Example** *(cannot take action based on Color Sensor until motor moves ball; Change the order of events in the code.)* **SAY/ASK** *Why do you think the code isn't working? Study each example to find the problem. Then fix it.*
28 **PROMPT** **Avoid the Edge: More with ELA**		**SEQUENCES** **CSTA 3-5 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **READING LITERATURE** **CCSS.ELA-Literacy.RL.4.3** Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions). **READING SKILL PRACTICE: STORY EVENTS**	• Describe the events in a story with specific details. • Modify the ending of a story. • Use Sound Blocks and Background Cards to add settings and events to a story.	Share that students have built models in response to many stories about Maria, Daniel, Sofie, and Leo as the friends travel to different settings. Prompt students now to build an alternative ending to one of those stories. Have them use the sounds and background cards in the LEGO® Education SPIKE™ App to add settings and interest to their story. As needed, show them how to access background cards by adding the Display extension. (Click the small + at the lower left of the programming canvas.) **SAY/ASK** *You've helped Maria, Daniel, Sofie, and Leo solve problems in stories within many different settings. But what if a story had a different ending? Choose one story and make a new ending. Use the background cards and sounds in your SPIKE App to add settings and interest to the story.* **MORE DETAILS** *Display Extension* (+ menu on the programming canvas); *Display Blocks* in the Help section of the SPIKE App, available on the web or downloaded.

	**Junior Pinball**			
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
29 	**Lesson**	**Modify Programs** **CSTA 3-5 1B-AP-12** Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. **Energy: Speed and Collisions** **NGSS 4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	• Apply their ideas to refine a solution that converts energy from one form to another. • Test the solution to improve and refine its function. • Engage effectively in a range of collaborative discussions.	After students build the junior pinball model, have them program it to start. Then prompt them to modify their program to make the game more unpredictable. Along the way, ask questions about energy. **Say/Ask** *Sofie finds a game she doesn't recognize. It's a junior pinball game. Build the game and then program it to play. Improve the game to be more unpredictable. What changes did you make to how or when the game converted potential energy to kinetic energy? How did the different obstacles impact the energy conversion?* **More Details** *Junior Pinball* lesson or access in the LEGO® Education SPIKE™ App
30 	**Prompt** **Jr. Pinball: More with Math** **Testing Symmetry**	**Modify Programs** **CSTA 1B-AP-12** Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. **Geometry** **CCSS.MATH.Content.4.G.A.3** Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. **Design Engineering** **NGSS 3-5 ETS 1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	• Revise a pinball game for symmetry across the board. • Test to determine how the symmetry changes the experience of playing the game.	Have students redesign their pinball game to ensure there is symmetry across the board. Let students test the model to see if that changes the experience of playing the game. **Say/Ask** *Remember our work with symmetry and buildings? Let's explore symmetry with Sofie's game. Redesign the model to make sure there is symmetry across the board. Then test it again. How, if at all, does the symmetry change the experience of playing the game?*

31	**PROMPT** **Jr. Pinball: More with CS: Variables and Scoring**	**VARIABLES** **CSAT IB-AP-09** Create programs that use variables to store and modify data. **DECOMPOSITION** **CSTA 1B-AP-11** Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. **INFORMATIVE WRITING** **CCSS.ELA-Literacy.W.4.2.D** Use precise language and domain-specific vocabulary to inform about or explain the topic.	• Create a simple program that uses a variable. • Use research sources to learn about rules of pinball games. • Write directions for how to play their pinball game, including rules for scoring points and winning.	. Challenge students to upgrade the pinball game by adding a way to keep score. Spark a discussion with students about scoring in other games they are familiar with, including video games. A score needs to change in a game. In some games, points are awarded and in other games, points are taken away. To create a score in a game using SPIKE Essential, we can use a variable. Ask students what they think a variable is in a computer program. In a program, it is a placeholder for a piece of information that can change. Have students open the SPIKE app on their device and launch a new program. Then have students click on the variable blocks and select "make a variable" Give the variable a name like "score". Have students connect the color sensor to the pinball machine to explore how the variable blocks work. Challenge students to make sure the score starts at "0" at the beginning of the program and increases by 1 when the sensor detects blue. Provide time for students to explore how these coding blocks work. Have your students research the rules of pinball and write the rules for their own junior pinball games, including how to score points and win. Provide appropriate research sources. **SAY** *Now that you've made your own pinball game, tell people how to play it. First, learn about the rules for other pinball games. Then write directions for your game. Include the rules for how to score points and win the game* Then have students redesign the Jr. Pinball machine to keep a simple score. Encourage students to break problems to solve into smaller pieces when developing a program (game resets to 0; game adds 1 point at a time; game ends when it should)

	**Creative Carnival Games**			
#	**Activity Name**	**Topic(s) & Standards**	**Objectives** Students will	**Prompt**
32 🕒🕒🕒	**Lesson**	**Energy: Speed and Collisions** **NGSS 4-PS3-1** Use evidence to construct an explanation relating the speed of an object to the energy of that object. **NGSS 4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide. **Energy: Transfer and Transformation** **NGSS 4 PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **NGSS 4-PS3-4** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. **Computational Thinking** **CSTA 3-5 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate. **Sequences** **CSTA 3-5 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. **Modify Programs** **CSTA 3-5 1B-AP-12** Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. **Data Analysis** **CSTA 3-5 1B-DA-07** Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea.	• Apply their existing scientific knowledge of energy transfer and collision to solve a problem. • Engage effectively in a range of collaborative discussions.	Have students create a new carnival game for Sofie, Daniel, Leo, and Maria to play. Prompt them to use at least one motor or sensor (e.g., Color Sensor). Provide additional materials and encourage brainstorming to generate multiple solutions. Then have students build and program their game. **Say/Ask** *Create a new carnival game for the Spike team to play. Brainstorm with classmates to think of several ideas. Then build and program your game. Use at least one motor or sensor.* **More Details** *Creative Carnival Games* lesson or access in the LEGO® Education SPIKE™ App

33	**PROJECT REBUILD THE WORLD: OCEAN ADVOCACY**	**CREATING PROGRAMS** **CSTA-1B-AP 10** Create programs that include sequences, events, loops, and conditionals. **PROGRAM DEVELOPMENT** CSTA 1B-AP-13 Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. **IMPACTS OF COMPUTING** **CSTA 1B-IC-18** Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices. **IMPACTS OF COMPUTING** **CSTA 1B-IC-20** Seek diverse perspectives for the purpose of improving computational artifacts. **DESIGN ENGINEERING** NGSS 3-5 ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	• Plan, design and program a device to protect waterways in an area. • Seek diverse perspectives when designing solutions. • Explore how technology can help solve real world problems.	Review the lesson Rebuild the World Ocean Advocacy. Shari Danni's challenge to design a device that can protect waterways in the area you live. Discuss with students how technology can help solve real world problems. As students design solutions to this challenge, have students plan the project based on the criteria and information provided by Danni. Then include opportunities for students to receive feedback from peers on their solutions for the purpose of improving the model. Have students share their designs, highlighting how the design meets the criteria and constraints of the problem.