Overview

This classroom manual is designed to provide ideas for how to use pages of the Kristel Pushes and Pulls e-book with students. It explains the concepts and suggests what to look for in students’ learning, while also supplying information about how they are practicing science and using crosscutting concepts.

The goals of this classroom manual are as follows:

• engage students in grade-level appropriate, three-dimensional learning;
• use the e-book as a tool in class-wide, small group, or independent explorations of its content;
• provide additional ideas and activities that utilize the e-book content but are not included in the e-book;
• explore how STEM content can be effectively integrated into literacy (English language arts);
• facilitate investigations that utilize the e-book content and connect it with students’ own classroom and community; and
• assess students on the second-grade content standards to which this e-book is aligned and additional Common Core State Standards, in English language arts and mathematics suggested throughout the e-book.

Book Description

The Kristel Pushes and Pulls e-book follows a young girl’s sense-making through everyday activities at home and soccer practice to explain how her mother’s bed mysteriously ended up in the tree in the front yard. Throughout her day, she explores how forces cause objects to change position, move different distances, and change speed and direction, as well as what happens when two forces collide with one another. Kristel guides students through the e-book’s interactive activities, in-class hands-on activities, and productive discussion to put into perspective how pushes and pulls control the motion of all our interactions with the world around us.

Many of the activities in this e-book and guide are intended to be used as a method of integrating the curriculum as well as differentiating for various populations in your class. All extensions and suggestions should be adjusted to meet the needs of the various
Topic 1

What Are Forces?

This topic introduces students to the world of forces. They will discover that nearly everything we do in a routine day is a result of two types of forces: a push or a pull. They will also learn to distinguish between the two forces and describe where an object acted upon ends up in relation to the force exerted on it. Students will engage with these concepts by following a young girl through a typical day off from school.

By the end of the topic, students will be able to:

• ask questions based on observations that the cause of all objects' movement is one of two types of forces: a push or a pull;
• construct an argument using evidence to explain how a force we exert that causes an object to move away from us is a push; and
• construct an argument using evidence to explain how a force we exert that causes an object to move toward us is a pull.
TOPIC 1: What Are Forces?

Turn to your table partner and explain what caused the objects to move.

- What caused the object to move the opposite direction? (The direction that Kristel passed [pushed or pulled] it.)
- What else will Kristel and her parents push or pull when they get up to leave the table? (Their chairs, their bodies, etc.)

When the students have investigated all the ways to move food around the table, they can check their thinking by clicking on that interactive element.

**Differentiated Instruction**

If students are having difficulty with the concepts of push and pull, do the following. Place a piece of masking tape on a desk. Have students stand behind the masking tape. Put an object on the masking tape. Tell students to push the object away from themselves. Tell students to pull the object towards themselves.

*Safety Note: Make sure that students are not throwing the materials or hitting things with them so they do not hurt themselves.*

Create a chart (or bulletin board) with the headers Push and Pull as shown in the example below.

<table>
<thead>
<tr>
<th>Push</th>
<th>Pull</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Push Image" /></td>
<td><img src="image2" alt="Pull Image" /></td>
</tr>
</tbody>
</table>

Have students analyze the pictures they drew the previous day and ask them to make a claim why they believe one or more of their observations should be categorized as a push or a pull.
Kristel is in her front yard playing with a soccer ball. To one side is her lawn and driveway; to the other is the flowerbed belonging to her next-door neighbor. Ask:

- Would the ball respond the same when it is kicked in the grass as it would on a hard playground? (No, it goes further on the playground. It also depends how thick the grass is.)
- What happens when the ball is kicked against the house? (It bounces off the house.)
- Can you explain what causes the ball to move differently? (The ball changes speed and/or direction when it hits an obstacle.)

Allow the students time to get their ideas and questions expressed and scribe and post them to refer to later as you reach the specific topics covered in this e-book. Now, take them outside to kick a ball back and forth with a partner.

Have students obtain, evaluate, and communicate information about kicking the ball to each other and kicking the ball. If possible, have students kick the ball across a smooth surface versus a grassy surface. Ask students what happens if a ball is kicked against a wall.

**Safety Notes:**

1. When doing this investigation be sure there are no free-standing objects in the play area to avoid the ball colliding with something and knocking it over.
2. Remind students they should not throw the ball, that they are lightly kicking the ball back and forth, and that the ball should NEVER leave the ground.
On her way to the soccer field, Kristel stops at the swings. She is curious why each of the swings climbs to different heights. Students are given the opportunity to push and pull the empty swing to investigate how each force affects the movement of the swing. Ask:

- What happens when we push the swing with a weak force? (Objects move less than with a stronger force.)
- How does pushing with a medium push affect the number of swings? (Pushing with a medium push made the swing go back and forth two times.)
- What about a strong push? (Pushing with a strong push made the swing go back and forth three times.)

This page has several “Check Your Thinking” stops. Set aside enough time to address any questions that arise as a result of the discussions.

It might be necessary to model what constitutes one full swing, showing students the starting point and the back and forth motion.

Students could be challenged to determine how many pushes it would take to have the swing go five full swings. Ask:

Can forces be added like numbers?

If I push the swing two times with a strong force will I get twice (double) the number of swings?

You can have the students model the swing’s behavior with a simple pendulum (a metal washer
Example Venn diagram:

**Extension Activity**

During Physical Education time, allow the students to play soccer, or just kick a ball around, but direct them to be prepared to construct explanations (claims) about how different strength kicks affect the ball’s behavior. Chart their claims in the room to refer back to as they investigate the phenomenon further.

**OUR CLAIMS ABOUT HOW FORCE STRENGTHS AFFECT AN OBJECT’S MOVEMENT**

<table>
<thead>
<tr>
<th>Weak Force Effect</th>
<th>Strong Force Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the ball is kicked weak ...</td>
<td>When the ball is kicked strong ...</td>
</tr>
<tr>
<td>So we can say, when objects are moved by a weak force they ...</td>
<td>So we can say, when objects are moved by a strong force they ...</td>
</tr>
</tbody>
</table>
The next drill that Kristel's soccer team does is an offensive skill. The goal of the drill is for each player to pass the ball to two teammates before taking a shot on goal. The students see additional information on the screen now: yard lines.

While the term vector arrow is not used (nor should be), students are asked to use this modeling element common in physical science to move the ball around the field.

Students can investigate numerous combinations of three vectors to pass and shoot the ball from different locations on the field. Ask:

- Is there only one way that you can score? (There is more than one way to score a goal.)
- Can you combine forces to have Kristel score the goal? (Yes. You can combine forces to score the goal.)
- Can you combine forces to have Kristel pass the ball to another teammate who scores? (Yes. You can pass the ball to a teammate to score the goal.)
- Which player is the farthest from the goal who can score? What strength force must she use? (Player 5 must use a strong (?) force.)

With the soccer field markings viewable this is a great opportunity to practice skip counting by 10s. Depending on the time of year, or proficiency of students, you could introduce the concept of difference as the ball travels back and forth across the field. Vocabulary that would be supported might include: difference, far, farther, less than, greater than.
Extension Activity

Students can play a game either in small groups or with the whole class to determine the effects of a collision. Create a chart similar to the one below.

<table>
<thead>
<tr>
<th>Force (right-cause)</th>
<th>Force (left-cause)</th>
<th>Result (Effect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>←</td>
<td>□ ←</td>
</tr>
<tr>
<td>□</td>
<td>←</td>
<td>□ ←</td>
</tr>
<tr>
<td>□</td>
<td>←</td>
<td>□ ←</td>
</tr>
<tr>
<td>□</td>
<td>←</td>
<td>□ ←</td>
</tr>
</tbody>
</table>

To play, hide either the effects or the causes. Have students discuss in teams and draw on a personal whiteboard to determine the hidden causes or effects. The game could be played in a game show fashion with time limits and the criteria that answers must be in a complete sentence or in a question format like on television game shows. Post words and phrases to for all to see.