Kindergarten

Forces, Motion, and Interactions

Teaching the Science and Engineering Education (SEEd) Standards

UVU College of Engineering & Technology
UTAH VALLEY UNIVERSITY

CREATIVE LEARNING STUDIO

UVU School of Education
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SEEd Strand K.3: Forces, Motion, and Interactions

The motion of objects can be observed and described. Pushing or pulling on an object can change the speed or direction of an object's motion and can start or stop it. Pushes and pulls can have different strengths and different directions. A bigger push or pull makes things go faster and when objects touch or collide, they push on one another and can change motion.

Standard K.3.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of forces on the motion of an object. Emphasize forces as a push and pull on an object. The idea of strength should be kept separate from the idea of direction. Non-contact forces, such as magnets and static electricity, will be taught in Grades 3 through 5. (PS2.A, PS2.B, PS2.C, PS3.C)

Standard K.3.2 Analyze data to determine how a **design solution** causes a change in the speed or direction of an object with a push or a pull. Define the problem by asking questions and gathering information, convey designs through sketches, drawings, or physical models, and compare and test designs. Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, or knock down other objects. (PS2.A, PS2.B, PS2.C, PS3.C, ETS1.A, ETS1.B, ETS1.C)

K.3.1-Bowling

Grade: Kindergarten

Lesson Topic: Force (push and pull)

Utah SEEd Standard:
Standard K.3.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of forces on the motion of an object. Emphasize forces as a push and pull on an object. The idea of strength should be kept separate from the idea of direction. Non-contact forces, such as magnets and static electricity, will be taught in Grades 3 through 5. (PS2.A, PS2.B, PS2.C, PS3.C)

Lesson Performance Expectations:

- Students will work in groups to discover the effects of rolling a ball using different forces to knock down pins.
- Students will **construct an explanation** for the **causes** of **change** in the movement of an object.
- Students will **develop a model/drawing** to show the **effects** of pushes and pulls on the motion of objects.

Phenomenon: The harder I push the ball, the more pins the ball knocks over.

Gather

1. Students will **explore** why some objects are more **stable** than others.
2. Students will **develop questions** that will help them **plan an experiment** to determine what **causes** objects to move.
3. Students will **execute their experiment to determine** what **causes** objects to move.

Reasoning

4. Students will **construct an explanation** for how different levels of strength of pushes and pulls **affect** the movement of the bowling pins.

Class Discussion:
Questions to initiate Discussion:
Q: What force did you use to knock down the pins?
Q: How does the push/pull affect the motion of the object (push away from, pull towards)?
Q: What caused changes in how many bowling pins were knocked down? What did you change to knock down all the pins?
Q: What can you do differently next time to get a different result or a more accurate result?

5. Students will **create a model through drawing** to show the **effects** of pushes and pulls on the motion of objects from their experiences with the bowling pins.

<table>
<tr><td colspan="2">Communicate Reasoning

6. Students will evaluate their explanation for the effects of different strengths of pushes or pull on the motion of objects then make any changes necessary to their explanation.</td></tr>
<tr><td>Science and Engineering Practices

Planning and carrying out and experimenting
Developing and Using Models (drawing their model)</td><td>Make careful observations that will turn into evidence
Use representations to describe phenomena
Use helpful models to explain phenomena</td></tr>
<tr><td>Crosscutting Concepts

Cause and Effect
Stability and Change</td><td>Identify and then describe the causes of phenomena through words and models
Distinguish between events, what's changing and what’s stable</td></tr>
<tr><td>Disciplinary Core Ideas

Force and motion</td><td>Pushes and pulls have different directions.
Pushes and pulls can have different strengths and can change speed, strength and/or direction of its motion.</td></tr>
</table>

Lesson adapted from:**Bowl me over**

Appendix A - Student Prompts for the Lesson

Phenomenon: When I push the ball hard, more pins are knocked over.

Group Performances:

1. Explore objects to find stable and unstable objects.
2. Develop some good questions to help us investigate what causes objects to move.
3. Investigate how to cause the bottles to fall over.
4. Explain what causes an object to move more or move less.

Class Discussion

5. Draw a picture to show the ball causing the pins to move.

Individual Performance:

6. Explain how forces cause an object to move by pushes and pulls.

Lesson steps:

1. Introduce the lesson by reading the Motion push and pull fast and slow book. Emphasize that engineers create devices that cause objects to move. Go over Vocabulary before you read:
    a. Push- To press, force or urge a thing to move away.
    b. Pull- To apply force to an object to cause it to move toward you.
    c. Motion- When an object moves to a different position or place.
2. Teacher demonstration - set up one set of bowling pins and one wiffle ball with a string tied to it. Ask the students what they think will happen if you swing the ball into the pins.
    a. Demo a few different speeds/ ways to hit the pins.
    b. Safety consideration: Balls stay on the floor for investigation/underhand throw. If students are not using the bowling sets correctly they will not be able to participate in the lesson.
3. Student investigation, use the bowling ball sets, and string tied to a wiffle ball. Students should knock over the pins using different forces (fast, slow, bouncy, hard, soft...etc.)
    a. The investigation is also an opportunity to incorporate mathematics. Students can count steps away from the pins before the ball is pushed toward them. You could also have students record how many pins they knocked over when they used different amounts of force.

4. As a class fill out the observation sheet, and discuss patterns that they notice. See questions above in the reason section.
5. Have students create explanations using these sentence starters.
    a. I think that (more/less) pins fell over because...
    b. I noticed that... which made me think…

(Teaching Suggestions: Class discussion should be happening throughout the investigation. Be careful to not do too much telling - try to help students to explain their own thinking at each step of the process. The practices and crosscutting concepts are new to K students so some time discussing the practices of **Investigation and explanations** as they are used and the crosscutting concepts of **cause & effect and stability and change** . Engage students in discussing **pushes and pulls**.)

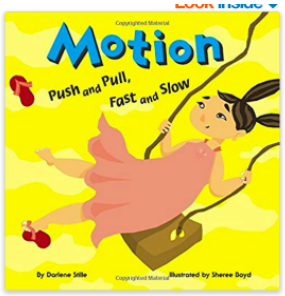
Appendix B -

Motion is when something (e.g. ball) moves. An object that changes position is not still. When an object is moving it is not stable. When you move you are not still. You are not in one place. To push is to move something away from you. Bigger/stronger pushes can move things farther and faster. If an object is heavy you will have to pull it harder to bring it closer to you.

Force is a push or a pull of an object that causes the object to speed up, slow down, or stay in one place. In other words, a force is what causes an object to move.

By **pulling** on something, you bring it closer to you. By **pushing** on it, you're moving it further away.

This book is an easy read (level A) book. It shows how different things move. (Reading A-Z)



Materials:

Provided Materials:

- Bowling set
- Wiffle ball tied to string
- Motion push and pull fast and slow physical book or Youtube read aloud.

Classroom Materials:

- Pencils
- Paper

K.3.1-Golf Investigation

Grade: Kindergarten

Lesson Topic: Force/Motion (push and pull)

Utah SEEd Standard:
Standard K.3.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of forces on the motion of an object. Emphasize forces as a push and pull on an object. The idea of strength should be kept separate from the idea of direction. Non-contact forces, such as magnets and static electricity, will be taught in Grades 3 through 5. (PS2.A, PS2.B, PS2.C, PS3.C)

Lesson Performance Expectations:

- Students will work in groups to investigate the effects of hitting a golf ball with different strengths of force trying to get it into the hole.
- Students will communicate their results with a drawing of how they hit the ball and where it went.

Phenomenon: Golf ball collision

Gather

1. Plan and an investigation to gather evidence for how to hit the golf ball into its hole.

Reason

2. Construct an explanation for what causes the ball to go in a certain direction.

Class Discussion:
Questions to initiate Discussion:
Q: What did you notice about the direction the ball moved?
Q: What caused the ball to move that way?
Q: Why does the ball move in a certain direction?
Q: Was our hypothesis correct? If not, how can we rewrite a statement to make it correct?

Communicate Reasoning
3. Develop an argument for how the evidence you collected supports or refutes your explanation for what causes the ball to move with different speeds.

Science and Engineering Practices	Plan and conduct an investigation to determine how to get the golf ball to move in certain directions

Plan and conduct and investigation	
Crosscutting Concepts	Hitting the ball with the golf club causes the ball to move.
Cause and Effect	
Disciplinary Core Ideas	Different directions of the forces on an object.
Force	

Appendix A - Student Prompts for the Lesson

Phenomenon: Slow Motion Golf Ball video

Group Performances:

1. Plan and an investigation to gather evidence for how to hit the golf ball into its hole.
2. Construct an explanation for what causes the ball to go in a certain direction.

Class Discussion

Individual Performances:

3. Develop an argument for how the evidence you collected supports or refutes your explanation for what causes the ball to move in a certain direction.

Lesson Steps:

1. Introduce the phenomenon by watching this video with the class and discuss what they saw. What made the ball move? What happened? Why do you think it happened?
    a. Emphasize that engineers study how to make things move the way they want.
    b. Introduce vocabulary:
        i. Push- To press, force or urge a thing to move away.
        ii. Pull- To apply force to an object to cause it to move toward you.
        iii. Motion- When an object moves to a different position or place.
2. Tell students they are going to be investigating how they can make the ball move in a certain direction.
    a. Discuss within their tables their hypothesis, or guess, to how they can make the ball move in a certain direction.
    b. Come together to form a class hypothesis on how to make the ball move in a

certain direction. Write the hypothesis on the board.

3. Put the students in groups of 3-4, give them a golf ball, a club, a tee, and a golf hole.
    a. Instruct them to (1) place the tee, (2) place the hole, and (3) place barriers to golf around in the range.
    b. Give students the recording sheet (in appendix b) and have them draw any barriers. Have the children each try to hit the ball into the hole, recording on their sheet which direction they hit the ball and where it ended up.
4. After about 5-10 minutes come back together as a class and show the recording sheet to have each group share what they saw or what happened. Revisit the class hypothesis and compare it to the data gathered on the sheets.
5. Sentence starters
    a. When I hit the ball with ____ part of the club it went ___(direction)__
    b. When I hit the ball with the middle of the club it went _____
    c. I could get the ball to go ___(direction) by hitting it like this___
6. Students will communicate their argument by using pictures or writing to explain how you can make a ball move in a certain direction.

Appendix B -

Phenomenon Video: slow motion golf ball collision

Materials:

Provided Materials:

- Golf balls
- Golf Club
- A Tee
- Golf hole
- Golf Investigation sheet

K.3.2-Building Marble Runs

Grade: Kindergarten

Lesson Topic: Force, Motion, and Interactions

Utah SEEd Standard:
Standard K.3.2 Analyze data to determine how a **design solution** causes a change in the speed or direction of an object with a push or a pull. Define the problem by asking questions and gathering information, convey designs through sketches, drawings, or physical models, and compare and test designs. Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, or knock down other objects. (PS2.A, PS2.B, PS2.C, PS3.C, ETS1.A, ETS1.B, ETS1.C)

Lesson Performance Expectations:

- Students will design and build a marble run to show the interaction of force and motion.

Phenomenon: Simple Rube Goldberg Machine

Gather

1. Plan an investigation to gather evidence for what causes machines to work.

Reason

2. Construct an explanation for the causes and effect relationships of different machines.
3. Students will analyze what the machine did well and what it did not do well.

Class Discussion:
Questions to initiate Discussion:
Q: What is the problem that we have?
Q: How can creating machines help us in our lives?
Q: What caused the machine components (the ball) to make it through the run?
Q: How could these machines be used in real life if they were bigger?
Q: Was there anything pushing objects in this machine?
Q: Why did the ball start moving?

Communicate Reasoning

4. Develop a model of your machine (marble run) you built, and explain one cool feature that the machine does.

Science and Engineering Practices	Analyze what cause and effects take place in different machines. Design a solution for how machines work.
Analyze data Design a solution	
Crosscutting Concepts	What causes the machines to do what they do, what effects does it have.
Cause and effect	
Disciplinary Core Ideas	Change in speed or direction using a push or pull.
Force and interactions	

Appendix A - Student Prompts for the Lesson

Phenomenon: Simple Rube Goldberg Machine

Group Performances:

1. Plan an investigation to gather evidence for what causes machines to work.
2. Construct an explanation for the causes and effect relationships of different machines.
3. Students will analyze what the machine did well and what it did not do well.

Class Discussion

Individual Performances:

4. Develop a model of your machine (marble run) you built, and explain one cool feature that the machine does.

Class discussion

Lesson Steps:

1. Show students This video to introduce the lesson. Explore the question, what is a machine? Emphasize that engineers build machines to help people accomplish tasks. You can show pictures of common machines (sewing machine, vending machine, etc.) and have students work together to come up with a class definition of machine. Go over the vocabulary:
    a. Machine- A system or device, such as a computer, that performs or assists in the performance of a human task.

2. The teacher can model what the students will be doing-designing a marble run.
3. For the investigation, students will work in groups of 3-4 to build a marble run machine.
    a. Using the marble run kits, have the students build one using the activity cards to get the hang of it.
    b. Problem: Getting the marble through the run. Solution: Placement of the pieces.
    c. Students can then design their own marble run without using the activity cards. They need to understand that the angles of the pieces affect the speed and direction the marble will go.
    d. Students also need to relate their run to a machine as it is helping them accomplish the task of moving the marble.
4. Have each group present their run to the class in a gallery walk.
    a. Sentence starters for presenting: "I WORKED HARD ON MY MACHINE. MY MACHINE IS INTERESTING BECAUSE _____."
5. When students are finished presenting, hold a class discussion using the following questions as a guide:
    a. What pushed pieces of the machine, making the ball move?
    b. How could this be used in real life (possibly if it were bigger)?
    c. What problems did you have with making the machine?
    d. How did you work through problems that came up when making the machine?

(Teaching suggestion: It would be fun to invite parents to the presentations if they'd like to attend.)

Appendix B -

Phenomenon Video: Simple Rube Goldberg Machine

Materials:

Provided Materials:

- Marble run- Trumble Trax
- Magnetic boards

Appendix-

Golf Investigation sheet

Golf investigation

Materials List by Lesson:

Most lessons will have their own box. When finished with the lesson, place all items back in the box they were found in.

K.3.1 - Bowl Me Over

Provided Materials:

- Bowling set (10)
- Wiffle ball tied to string (2 bags with 32 total)
- I Fall Down book (3)

Classroom Materials:

- pencils

K.3.1 - Golf Investigation

Provided materials:

- Golf balls (38)
- Golf Bags (7)
- Tees (14)
- Golf hole + Flag (15)

K.3.2 - Building Marble Runs

Provided Materials:

- Marble run- Trumble Trax (10 marble sets which included 14 magnet pieces, 4 marbles and 10 building cards)
- Magnetic Surface Boards (4)