A Force in Motion: An Embodied Learning Unit on Forces and Motion

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Bain Elementary School

This curriculum unit is recommended for:
K-2 Science and Literacy

Keywords: force, motion, push, pull, kinesthetic learning, embodied teaching, universal design for learning (UDL)

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This unit will use universal design for learning strategies to teach force and motion concepts to lower primary students. These strategies will include movement studies and hands-on activities in which students will be able to show mastery of their learning. Force and motion concepts included in this unit are pushes, pulls, magnets, balanced forces and unbalanced forces. Featured Universal Design for Learning strategies include use of visuals and choice in learning presentation.

I plan to teach this unit during the coming year to 19 students in First Grade**,** Science**.**

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Introduction

Webster's Dictionary defines "embodied" as giving a body to or to make concrete and perceptible. It follows that strategies for Embodied Learning stand to give body to learning or to make learning concrete and perceptible. These strategies for teaching are ways to engage learners through sensory experiences and through the participants' multiple learning styles.

This unit seeks to employ embodied teaching strategies to develop students' understanding of concepts and ideas around force and motion. Students will explore the concepts of push, pull and static equilibrium through kinesthetic and other sensory experiences. Students will have multiple opportunities to show their understanding of the topic in different formats.

Rationale

Students are currently returning to school, some of them after an entire year of virtual learning at home. This year's students especially need opportunities to collaborate and experience their learning in different modalities. Paper and pencil only is not going to cut it this year.

Embodied Teaching and Learning encompasses many different learning styles while providing opportunities for participants to engage their senses (I use the word "participants" because the instructor should be engaged in the process as well). Participants will create and reflect on their actions while analyzing causal relationships. This method of experiencing learning should enable participants to express their creativity while sharpening their problem-solving skills. Participants should be challenged to think in new and different ways. They should also be able to offer active, constructive feedback on others' work with the goal being an improved final product.

This year's students need concrete opportunities to touch, feel, hear and smell things as much as possible (first graders typically need these types of learning experiences often, regardless). By using these strategies, teachers can cement their students' understanding of the topic included in the unit, and, hopefully find ways to adapt the strategies to other academic areas.

School Demographics

Bain Elementary School is a Kindergarten through Fifth Grade School in the Charlotte-Mecklenburg Schools District. Charlotte-Mecklenburg Schools is the second

largest school district in North Carolina and the eighteenth largest in the nation.[1] Almost 150,000 students are taught in 176 schools throughout the county.[2]

Bain Elementary School was founded about 120 years ago in Mint Hill, a suburb of Charlotte. Almost 1,000 students attend the school, between the two buildings on the campus.[3] According the NC Schools Report Card, provided by the North Carolina Department of Public Instruction, in the 2019-2020 school year 22.1% students came into Kindergarten with skills at or beyond levels expected for Kindergarten. 19.7% of students are economically disadvantaged, compared to North Carolina, 43.4% of students are considered economically disadvantaged. Bain has a staff composed of 93.7% experienced teachers and only 6.3% new teachers (the district shows percentages 83.4% and 6.8% respectively).[4]

I currently teach in a first grade general education classroom with 19 students. Students attend Special Area classes in Music, Physical Education, Art, B5 Sensory Lab, Library and STEAM Lab. On a further note, B5 Sensory Lab is a time for students to explore sensory activities. These activities are designed to help students build upper body strength and work on crossing their mid-lines.

Content

Embodied Teaching and Learning, Universal Design for Learning

Universal Design for Learning is a teaching approach, with deliberate planning, that meets the needs of every student. "Universal," in this context, refers to the needs of all students, not that every student is taught the exact same way. This is a thoughtful process meant to engage every student using a variety of tools and techniques.[5]

How do teachers engage every student? It is very important to understand the barriers that students are facing in the classroom. Some of these barriers fall under one large umbrella, skills in executive function.

Executive function includes three areas: working memory, flexible thinking and inhibitory control. Within these three areas fall organizational skills, the ability to pay attention and controlling emotions.[6] Deficits in these skills could pose huge problems for students.

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[1] "Charlotte-Mecklenburg Schools."
[2] "Background, Facts and History."
[3] "About Our School."
[4] "Bain Elementary."
[5] "What Is Universal Design for Learning (UDL)?"
[6] "The 3 Areas of Executive Function."

Working memory involves a student's ability to hold onto the information they learn and use it in some way. It is considered a short-term memory skill and is a step on the way to being able to store information in your long-term memory. A student with challenges in this area may store information as a jumble or may not be able to store information long-term at all.[7]

Being able to think about information or a strategy in more than one way is called flexible thinking. Challenges in this area may appear as struggles with changes to routine or a schedule or being unable to understand that one strategy may not work for all problems. A student with these challenges may argue their point repetitively or seem extremely rigid in their thinking.[8]

Inhibitory control, or self-control, can be broken down to three main areas: movement control, impulse control and emotional control. While these skills develop more and more until a student is in their 20's, certain developmental milestones can be seen. Challenges in this area may manifest as blurting out, tantrums, giving up easily or grabbing items without asking.[9]

Universal Design for Learning is a framework to aid students in accessing their learning through these types of challenges. Students are taught how to become expert learners. To accomplish this goal, there are three main tenets in this type of planning: engagement, representation and action and expression.[10]

Engaging students often begins with the end goal in mind. Students should know what they are expected to do at the end of the unit. How the students get to that point should involve some choice on their part. Offering students some choices over their work allow them to work in a way that is most comfortable to them. Along with that, creating a safe learning environment is of high importance. Students should also receive timely feedback that includes their progress towards mastery of that goal.[11]

Planning different ways for students to access the material falls under representation. How can you provide the information in a visual format? How can you provide auditory cues? These are questions to reflect upon as lesson planning is progressing. Hands-on learning opportunities fall under this category. Providing students with key experiences gives them a concrete reference to use and analyze during their unit. Teachers need to think carefully about how to move students to a higher level of understanding and comprehension.[12]

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[7] "What Is Working Memory?"
[8] "Trouble with Flexible Thinking."
[9] "What Is Self-Control?"
[10] "UDL: The UDL Guidelines."
[11] "UDL: The UDL Guidelines."
[12] "UDL: The UDL Guidelines."

Lastly, teachers need to plan for multiple means of action and expression. What are different ways that students can show mastery of the end goal? In what ways can students interact with different tools or technology? Also, think about what scaffolding needs to be provided to remove any barriers that students may have.[13]

Some of these strategies are probably already in place in many classrooms. This a framework designed to help all students succeed and many of these strategies are just good ideas to begin with. There is nothing better to teach a student than how to become an expert learner.[14]

Force and Motion

North Carolina First Graders work with understanding the ideas behind force and motion. Students develop an understanding of how forces can change the movement of an object, that some forces can move objects without being seen (magnetism) and be able to predict how a force can act on an object.[15]

First, let's discuss the physics. Here is where Newton's Laws of Motion come into play. Newton's Laws are:

- An object at rest remains at rest, and an object in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force.
- The acceleration of an object depends on the mass of the object and the amount of force applied.
- Whenever one object exerts a force on another object, the second object exerts an equal and opposite on the first.[16]

Newton's First Law of Motion, referred to as the Law of Inertia, is a great exploration for students. Objects at rest remain at rest. Objects in motion remain in motion unless acted upon by an unbalanced force. Students can easily observe this law by watching objects around them. What are forces that can act upon objects? Pushes, pulls, gravity and friction.

A push is a force that moves on object away from the origin of the force.[17] Any force that causes something to move away from you is a push. Pushes are rockets launching, sliding your chair in and walking. Even in walking, your feet are pushing your body away from the ground and your feet.

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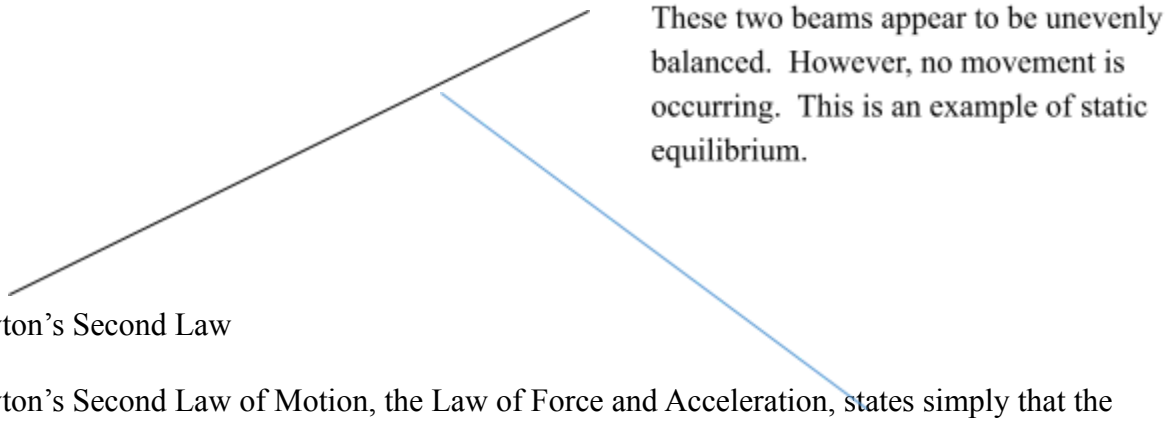
[13] "UDL: Use Multiple Tools for Construction and Composition."
[14] "UDL: The UDL Guidelines."
[15] "NC K-2 Science Essential Standards."
[16] "Newton's Laws of Motion."
[17] "Definition of PUSH."

A pull is a force that moves something closer to the origin of the force.[18] Playing Tug of War is a great example of a pull, along with pulling paper towels off of the roll and pulling a wagon.

Friction is defined as the force that resists relative motion between two objects.[19] If there were no friction, things would go on forever. There would be no force acting upon an object to stop it.

Gravity is defined as the natural force that tends to cause physical things to move towards each other or pull objects to the center of the Earth.[20] Of course, the legend is the Sir Isaac Newton came up with the idea of gravity because of a falling apple. What force had to be acting on the apple to cause it to move from rest?[21]

The idea that forces have to be unbalanced to make something move is really a thought provoking concept. Here, the exploration of the idea of static equilibrium would be worthwhile. An object is considered in static equilibrium if the forces are acting upon it are balanced. The diagram below shows static equilibrium even though the objects do not appear to be equal.



These two beams appear to be unevenly balanced. However, no movement is occurring. This is an example of static equilibrium.

Newton's Second Law

Newton's Second Law of Motion, the Law of Force and Acceleration, states simply that the greater the mass of an object, the greater the force needed to move it. So many examples come to mind here. Students can use a variety of objects to explore this concept. They could move toy cars and then try to push a real car. Students could roll each other around in a wagon or a rolling chair. Then, what would happen if they tried to move their teacher? The differences in the forces needed to move each object should be obvious to students.[22]

Newton's Third Law

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[18] "Definition of PULL."
[19] "Definition of FRICTION."
[20] "Definition of GRAVITY."
[21] "Gravity."
[22] "Law of Force and Acceleration - Newton's Second Law of Motion - Physics Video by Brightstorm."

Newton's Third Law, the Law of Action and Reaction, is the idea that forces occur in pairs.[23] These paired forces act in equal strength and opposite direction.[24] It is difficult to think that when you take a step on the ground, the ground is pushing back. This can be a tricky concept for students to understand. Concrete examples/experiments of students exploring this idea would be the most helpful. What happens when toy cars collide? What happens when you bounce a ball against a wall?

More on Friction

- the force that resists relative motion between two bodies in contact[25]

Friction occurs when any two objects are rubbing against each other. There are four types of friction: static, sliding, rolling and fluid. Each type of friction has very different examples and there are several factors that influence the amount of friction that is seen:

- surface deformation (wrinkles, cracks) of the objects
- roughness or smoothness of the surfaces of the objects
- speed at which the objects are moving when they make contact
- size of the objects
- amount of pressure on either object
- how adhesive the surfaces of the objects are[26]

Static friction is the force that keeps an object at rest.[27] Think of an object resting on a table or a car parked on a hill.[28] These forces in play here are equally balanced so that no motion occurs.

Sliding friction is self-explanatory. Any two objects sliding against each other create sliding friction. Your students can explore this concept easily by using toy cars. Why do they think the car eventually slows down and stops?

Rolling friction, again, is self-explanatory. What is interesting about this type of friction is that it is classified as the weakest type. Deformations on the surfaces of the rolling objects greatly influence that amount of friction that is seen.[29]

Lastly, fluid friction is the friction that occurs between two moving fluid layers (liquid or gas). Think about viscosity. This is actually a fluid's internal resistance to

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[23] "Newton's 3 Laws of Motion For Kids [with Examples]."
[24] "Newton's 3 Laws of Motion For Kids [with Examples]."
[25] "Definition of FRICTION."
[26] "Examples of Sliding Friction: What It Is in Simple Terms."
[27] "Static & Kinetic Friction."
[28] "What Is Static Friction?"
[29] Lalotra, "Rolling Friction - Definition, Examples, Coefficient, Causes, Formula."

shearing. A fluid's thickness is usually associated with its viscosity.[30] There are several classifications of fluids and if you are teaching on the states of matter, this could be a very interesting discussion (ketchup is considered a non-Newtonian fluid, in case you were wondering).[31]

Begin with the End in Mind: Unit Goals and Outcomes

While teaching this unit, the students will:

- show a pushing force and modify their movement for objects they think have more mass.
- show a pulling force and modify their movement for objects they think have more mass.
- show balanced forces accurately.
- show attracting and repelling forces as with magnets.
- read grade-level appropriate non-fiction texts.
- work in groups to create a movement scenarios that explain the given movement concept.

At the conclusion of this unit, students will be able to:

- analyze how forces can affect the movement of an object.
- perform their movement scenarios with an audience in mind
- explain how magnetic forces can move some objects

The Plan: Instructional Implementation

Materials needed to implement this unit are:

- chart paper (prepare chart with end learning goals listed in advance)
- markers
- student notebooks/journals
- student devices, Seesaw App
- jump ropes, enough for pairs of students to have 1
- *Give it a Push! Give It a Pull!: A Look at Forces* (available for free on epic! online library)
- construction paper, at least 12 x 18 in size
- rubber balls (enough for each pair of students to have 1)
- toy cars (enough for each student to use 1)
- materials that can be used to build ramps (cardboard, laminating film tubes, books)
- carpet squares or other carpeted surface
- magnets (different types)
- a variety of small objects that are magnetic and non-magnetic (each student should have four to five items)
- picnic paper plates

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[30] "Fluid Friction."

[31] "Ketchup Is Not Just a Condiment: It Is Also a Non-Newtonian Fluid - Scientific American."

- magnetic marbles
- strong round magnets
- 10 hex nuts per student
- unsharpened pencils ~ one per pair of students
- blocks

Vocabulary
- push ~ a force that moves an object away from you
- pull ~ a force that moves an object closer to you
- direction ~ the pathway that an object is following as it moves
- friction ~ force created by two objects rubbing together
- magnet ~ an iron object that can attract or repel other objects that contain magnetic metals
- attract ~ a pulling force
- repel ~ a pushing force
- balanced forces ~ two forces acting with the same strength but in the opposite direction. Balanced forces do not cause a change in motion.[32]
- unbalanced forces ~ change the motion of an object (speed, direction, etc.)[33]

Day One, Introduction to Unit, What is a Push?

Tell students that today they are going to start exploring how things move and what happens when things move. Prepare an anchor chart with these end goals listed:
- I will be able to describe and identify the forces that make objects move.
- I will be able to describe and identify the forces that make on object change direction.
- I will be able to explain how friction slows objects down.
- I will be able to describe and identify forces that attract and repel.
- I will be able to describe and identify balanced and unbalanced forces.
- I will show what I have learned using movement that an audience will get to view.

Tell students that to accomplish these goals, we are going to be using movement! First, we need to learn a little about how things move. Have students turn and talk with a partner about what they know about movement. Record their ideas on chart paper. Even if there are some misconceptions, record those as well. You can go back and revisit those ideas throughout the course of the unit and have students see if they have changed their thoughts.

Now, tell students that today we are going to work on our first goal. Tell students to think about a push. What does it look like? What does it feel like? Have students model pushing in their own space. Ask students what it would look like to push something really big. Show an image of a large boulder (Appendix 2).[34] What about what it would look like

[32] "Balanced & Unbalanced Forces | Science Lesson For Kids | Grades 3-5."
[33] "Balanced & Unbalanced Forces | Science Lesson For Kids | Grades 3-5."
[34] "Boulders Rocks Formation - Free Photo on Pixabay."

to push something small and lightweight? Show the image of the feather (Appendix 2).[35] What about a toy ball? (Appendix 2).[36] Have half of the class show their movements while the other half of the class observes. Discuss what the audience saw. Discuss what the "performers" felt doing those motions. Then, switch the groups and repeat the same procedure.

Lead students to the idea that a push is a force that moves an object away from you. What was different in their movement when "moving" something large and heavy versus something small and lightweight? It takes a bigger force to move an object with a larger mass. Record these ideas on a separate chart and review. Students can complete Exit Ticket for Day One. Allow students to complete the ticket on paper or on a recording app such as Seesaw.* According to the UDL framework, provide feedback in a timely fashion.

*Posting work on Seesaw allows other students and families to see what that student has been working on.

Day 2, What is a Pull?

Tell students that today we are going to begin working on our second end goal, describe and identify a pulling force. Remind students that a pushing force moves an object away. If that is the case, what do they think a pulling force would do?

To explore this idea, take your class outside. Put students into pairs. Pass out jump ropes to each pair. Remind students of expectations for movement in the classroom and with each other. Students should be careful to not hurt each other. Have students each hold one end of the jump rope. One student should pull on their end of the jump rope gently. What does the other student feel happening? Discuss what students felt. Lead students into the idea that a pulling force brings objects closer to you. Have students experiment with pulling a few more times. What else can they try to pull?

Read *Give It a Push! Give It a Pull!: A Look at Forces* by Jennifer Boothroyd, pages 1-20. Ask students to discuss if anything was surprising to them in the story (using forces to write, broken glass, hitting a ball against a wall). See Reading Guide in Appendix 2.

Have students complete the Exit Ticket for Day Two. Students should be given the option to use paper and pencil or to use a recording app such as Seesaw. According to the UDL framework, provide feedback in a timely fashion.

Day 3, Forces Change the Direction of Objects

Review ideas from the anchor chart with students. Discuss pushes and pulls. Students should now know that forces, pushes and pulls, make objects move. Students have now

[35] "Free Images."
[36] "Free Images."

worked on their first end goal. Remind students to keep how they felt when experimenting with pushes and pulls. This will be used in their final products,

Tell students that today we are going to do an exploration using pushes and pulls. First, ask students what they think of the word "pathways." Lead students to the idea that a pathway is a trail, or a route, that an object travels. Show students that pathways can take several different forms: zig-zags, curves, spirals and straight lines. Pass out construction paper. Model drawing a path on a paper, then have students draw their own pathway on the paper, the long way from top to bottom. Students may use a combination of forms to draw their path.

Now, tell students that their job today is to try to keep a rubber ball on the path. Let students explore what has to happen to keep the ball on the path. Students should be using pushes and pulls to keep the balls on the lines.

After an appropriate amount of time, call students back to discuss what they experienced. How did students keep their balls on the lines? (by using pushes and pulls) How difficult was it?

Reread *Give It a Push! Give It a Pull!: A Look at Forces* by Jennifer Boothroyd, pages 15-21. Discuss with students where they have noticed an object traveling in one direction and a force acted upon it to change its direction.

Have students complete the Exit Ticket for Day Three. Students should be given the option to use paper and pencil or to use a recording app such as Seesaw. According to the UDL framework, provide feedback in a timely fashion.

Day Four, Forces and Moving Objects

Review the previous days' work. Have students review how they would show pushes and pulls with movement and action. Mention specifically how forces can change the direction of an object. Tell students that today they are going to explore moving objects in a different way today. Tell students that today they are going to find a way to make a ramp. Explain/show several examples of ramps (see provided examples in Appendix 2).

Students are to use materials from the classroom to build a ramp. Once the ramps are ready. Students will now get to experiment with their ramps using toy cars. Give students a few minutes to use the toy cars on the ramps. Have students observe what is happening.

Now, have students place a "wall" at the end of their ramps. Students should now have their cars travel down the ramps and note what happens when the cars hit the wall. Using what the students now know about pushes and pulls, how can students explain what happened. Does the wall move? (The wall pushes back against the car, moving it back.)

Students can also experiment with having their cars hit each other. Do they notice the same thing happening? If there a gym space available, take students there. Partner students and give each pairing a rubber ball (used the previous day). Model bouncing the balls against the wall. Clearly explain rules and expectations for using the balls. Have students notice what is happening. Where are the forces acting? (The student pushes, or throws, the ball against the wall. The wall pushes the ball back in the opposite direction.)

Close the activity out with a discussion. Make sure to review that the "walls" were acting on the objects to change their direction.

Have students complete Day Four Exit Ticket in Appendix 2. Students should be given the option to use paper and pencil or to use a recording app such as Seesaw. According to the UDL framework, provide feedback in a timely fashion.

Day Five, Friction

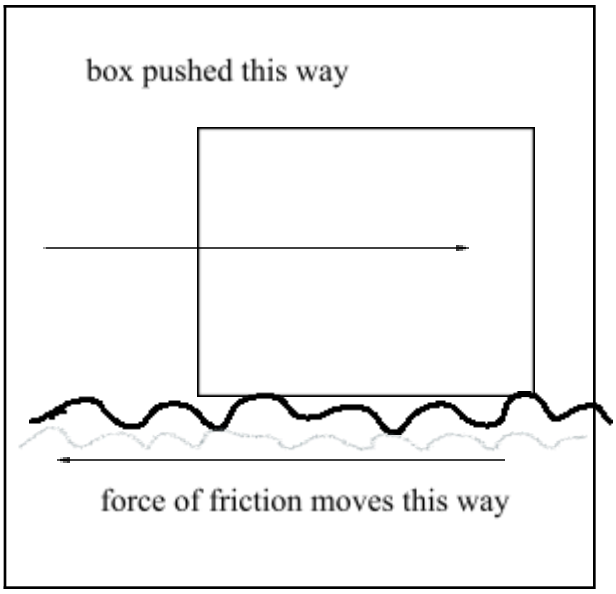
Review end goals with students. Students should now be able to talk about the first two goals and show/tell about the related vocabulary words. Tell students that in today's exploration we will be using the toy cars again. The students' job today is observe what happens when the toy cars travel over two different surfaces.

Pair students up. Give each student a toy car. Students will work with partners to record/write their observations as they roll their toy cars over at least two different surfaces (i.e. one carpeted, one smooth tile). Students may use Seesaw app to record video of their work.

Bring students back together. Discuss their findings. What happened when students were able to roll their toy cars over the carpet? (the cars slowed down, the cars did not travel very far). What happened when students rolled their cars over a smooth tiled surfaced? (The cars traveled a greater distance, they took longer to slow down). Introduce the word "friction." Friction is why the moving objects eventually slow down.

Read *Why Do Moving Objects Slow Down?: A Look at Friction* by Jennifer Boothroyd. Discuss the examples and pictures seen in the book. Note the helpful types of friction and the times that friction is not so helpful. This visual might help explain the concept to students.

bumpy surface



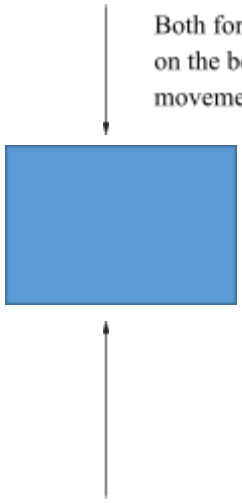
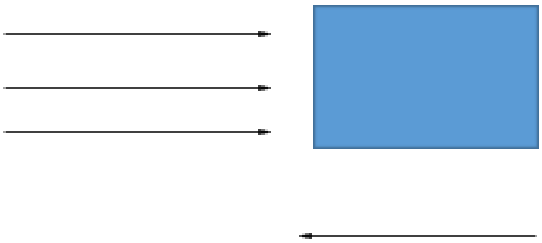
Show this clip, "Slipping, Sliding Science" by SciShow for Kids. Discuss the student's own experiences with friction (i.e. rubbing hands together, going down the sliding board). Now the students are going to draw a toy car design that they think will reduce friction. Have students take out their science journals or notebooks. Have the students draw a picture of a scenario that shows friction. Have them label where the forces are acting. Students should be given the option to use paper and pencil or to use a recording app such as Seesaw (students can act out a scenario or use objects to show). According to the UDL framework, provide feedback in a timely fashion.

Day Six, Balanced and Unbalanced Forces

Review previous days' work with students. Today students are going to work on exploring balanced and unbalanced forces. Show students the image of the balancing rocks in Appendix 2, Day Six. Ask for their thoughts on the picture. Record student ideas. Students should notice that the rocks are not moving. Does this mean that forces are not acting on the rocks? No. The forces are balanced.

Now, show the video clip "Tug-of-War Championships" in Appendix 2, Day Six. What do students notice about this? One team is pulled toward the other. Are those forces balanced or unbalanced? Those forces are unbalanced. Unbalanced forces cause objects to move or to change direction.

Pair students up. Pass out some blocks or building toys to each group. Have each group try to build the tallest tower that they can. What happens when their towers fall? What happens when their towers are knocked down? The forces acting on the towers, causing them to fall, were unbalanced.

Balanced Forces	Unbalanced Forces
Both forces are equal on the box. No movement. 	More force is pushing on the box than the force of friction underneath the box. The box to the right. 

Day Seven, Introduction to Magnets, Magnetic Forces are Invisible!

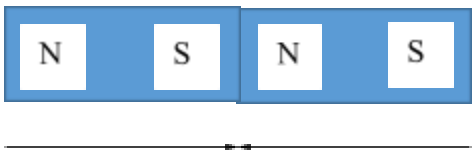
Review previous days' vocabulary words (push, pull, direction, friction). Remind students to be thinking about how they can show each of these ideas with movement.

Now, tell students to think about how they know forces are acting on objects. Students should mention that they see objects moving. Put a paperclip on top of a picnic paper plate. Hold a magnet on the underside of the plate. Move the magnet. The paperclip should move. Ask students what they observe. There is a force acting on the paperclip. They know because they see the paperclip moving. However, what force is acting on the paperclip?

Show students the magnet under the plate. Explain that you were using a magnetic force to move the paperclip. Sometimes you do not even see the forces that are acting upon an object. Sometimes that is a magnetic force.

Read *Attract and Repel: A Look at Magnets* by Jennifer Boothroyd. Ask students to think about 3 important facts from the text. Have the students turn and talk to share their facts with each other. Use visuals to help solidify student understanding.

Opposite poles attract.	Like poles repel.
Pull	Push
	

Now, students are getting the chance to explore with the magnets. Pass out the magnets and items for exploration. You may use a table like the one listed in Appendix 2 for students to record their observations on.

Have two sheets of chart paper prepared with the headings "Magnetic" and "Not Magnetic." After an appropriate amount of time, have students come to the classroom carpet to review their results. Ask students what items that they tested should go on the "Magnetic" chart. Record their ideas. Repeat for the "Not Magnetic" chart. Have students look at all of the items that are listed on each chart. What do they notice about how the items are sorted? (All of the items on the "Magnetic" chart are made of certain types of metal.) Have students return to their seats and try to move one of their magnetic materials with a magnet. What type of force is being used, a push or a pull? Review the words "attract" and "repel." Which word names a pulling force? Which word names a pushing force? If you have a way to stack magnets, try that now. Show students what happens when opposite poles are facing each other and when like poles are facing each other. Students should say that they can tell that the poles are like or opposite.

Have students complete Day Six Exit Ticket in Appendix 2. Students should be given the option to use paper and pencil or to use a recording app such as Seesaw. According to the UDL framework, provide feedback in a timely fashion.

Day Eight, Magnetic Forces Can Move through Objects

Review previous day's work with the words attract and repel. Explain that you will be using these words even more today to make two special items.

First, using the paper plate, show students how to draw a pathway on the paper plate. Students will then use magnets under the plate to make the marble travel the pathway on top of the plate. See the example below.

Also, today students are going to use the round magnets as a base to build a sculpture out of hex nuts (or other magnetic odds and ends). In this activity, students should see how many hex nuts that they can stack on the magnet before the force weakens too much.

Have both stations prepared and rotate students through both. If there is time, ask students if they think the magnet will make objects move through their desk. Draw a pathway on the desk with dry-erase marker and stick the magnet inside the desk, but close to the work surface. Does it work? Will the force even travel through the desk top?

Have students complete Day Eight Exit Ticket in Appendix 2. Students should be given the option to use paper and pencil or to use a recording app such as Seesaw. According to the UDL framework, provide feedback in a timely fashion.

Days Nine and Ten, Final Product

Review with students everything that they have learned. Show them all they have accomplished on the end goal chart. Ask if anyone still has any questions about any of the end goals.

Today, since the students have been learning so much about how things move, they will work on ways to show their learning with movement. When they first learned about pushes and pulls, students used movement to show their ideas. Now, they will use those movements again in sections or segments to show all that they have learned.

Students will need to think about these big ideas in their work: pushes (repel), pulls (attract), invisible forces, friction, balanced and unbalanced forces. Have an anchor chart prepared for students to reference during their work time. Divide students into groups. Tell students that they must have 30 seconds to 1 minute of movement to show each concept listed on the chart. They may record their movement or perform it in-person for the class. They may also use "props," with teacher permission. Are you going to have a narrator? Are you going to use posters? These are some of the questions that the students should think about while working on their presentation.

Students should work to illustrate each concept. The concept should be clear in student work. Remind students that if someone else were to walk in and see what they are doing, that person should be able to tell what the group is trying to show. Students should be able to prepare their presentations in the Day Nine Session and present in the Day 10 session. A rubric is included in Appendix 2 for assessing student work.

Appendix 1: Implementing Teaching Standards

Teaching Standards Addressed in this Unit

Days One, Two, Three, Four, Five

K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.[37]

1.P.1 Understand how forces (pushes or pulls) affect the motion of an object.

1.P.1.1 Explain the importance of a push or pull to changing the motion of an object.

Days Two, Three, Five, Six

RI.K.1 With prompting and support, ask and answer questions about key details in a text.

RI.K.4 With prompting and support, ask and answer questions about words in a text.

[37] "K-PS2-1 Motion and Stability: Forces and Interactions | Next Generation Science Standards."

W.K.4 With guidance and support from adults, explore a variety of digital tools and resources to produce and publish writing, either in collaboration with peers or in a whole group setting.

RI.1.1 Ask and answer questions about key details in a text.

RI.1.2 Identify the main topic and retell key details of a text.

W.1.4 With guidance and support from adults, use a variety of digital tools and resources to produce and publish writing, including in collaboration with peers.

RI.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.

W.2.4 With guidance and support from adults, use a variety of digital tools and resources to produce and publish writing, including in collaboration with peers.

Days Six, Seven

1.P.1.2 Explain how some forces (pushes and pulls) can be used to make things move without touching them, such as magnets.

Day Eight

1.P.1.3 Predict the effect of a given force on the motion of an object, including balanced forces.

Appendix 2: Implementing the Unit

Day One

38

39

[38] “Boulders Rocks Formation - Free Photo on Pixabay.”
[39] “Free Images.”

 [40]

All photographs are cited in bibliography and are available under a Creative Commons License.

Day One Exit Ticket

Name:_____ **Date:** _____

What does a pushing force do to an object?

_____

_____

[40] "Free Images."

Day Two Exit Ticket

Name:_____ **Date:** _____

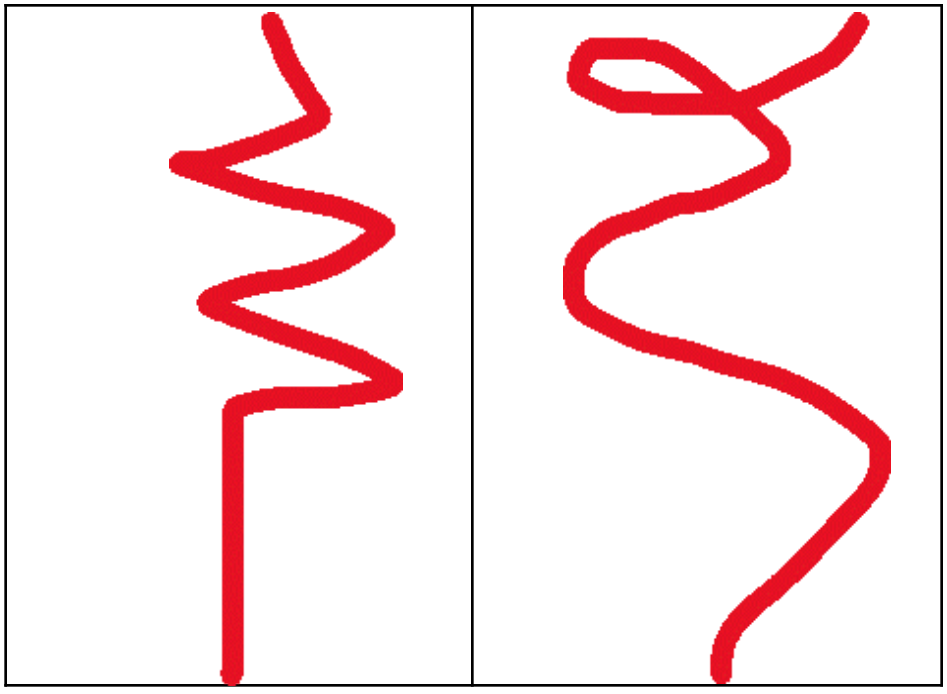
What does a pulling force do to an object?

_____

_____

Day Three

Samples of Pathways



Day Three Exit Ticket

Name: _____ Date: _____

Write about using a force to change the direction of an object.

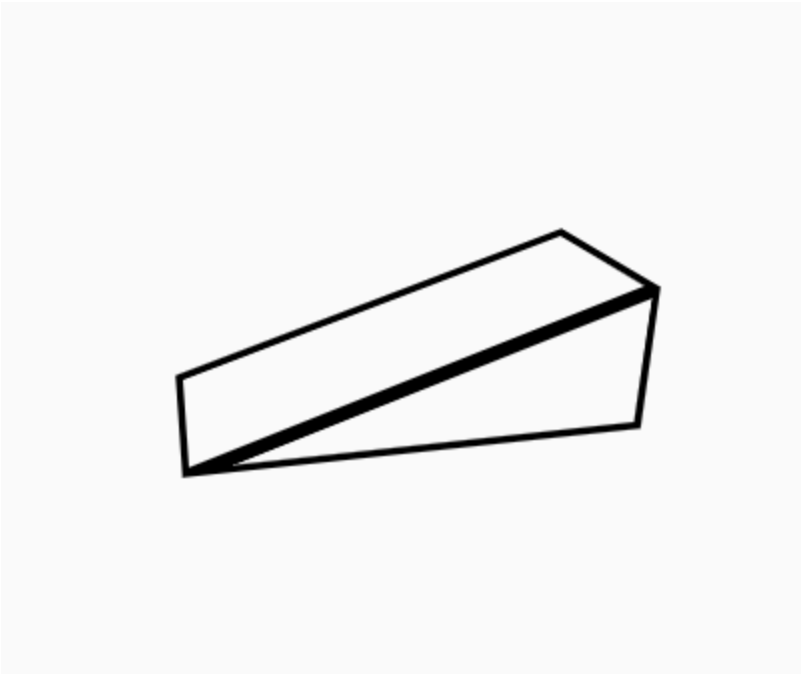
_____

_____

_____

_____

Day Four

 [41]

 [42]

Pictures cited in bibliography and are available with Creative Commons License.

[41] "The Noun Project."
[42] "Geograph."

Day Four Exit Ticket

Name: _____ Date: _____

In the space below, draw a diagram of the ball hitting the wall. Use arrows to show where the forces are acting.

Day Six Exit Ticket

Name:_____ **Date:**_____

Are the forces balanced or unbalanced?

An apple falls from a tree.	Balanced	Unbalanced
A cup is sitting on a table.	Balanced	Unbalanced
A car is driving on the road.	Balanced	Unbalanced
A tower of blocks tumbles down.	Balanced	Unbalanced

Day Seven

Item	Magnetic	Not Magnetic

Day Seven Exit Ticket

Name: _____ Date:_____

Draw a diagram that shows how a magnet can move an object without touching it.

Day Eight

Name:_____ Date:_____

Draw a diagram of either your sculpture or your marble maze. Show where the magnets are and how the magnetic force is traveling through the objects.

Final Student Presentation Rubric

Concept	Score
Student effectively showed that pulls move objects closer.	
Student effectively showed that pushes move objects away.	
Students effectively showed that invisible forces can sometimes act on objects.	

Students effectively showed that friction is a force created when 2 objects rub together.	
Students effectively showed that unbalanced forces cause objects to move.	

*Smiley faces[43]

Final Student Self-Assessment

	Score
I did the best work I could in my team.	
I shared my ideas with my team.	

[43] "Free Image on Pixabay - Emoji, Smile, Sad, Emoticon, Smiley."

I showed the movement ideas well.	
I asked questions when I did not understand something.	

Appendix 3: Annotated Teacher Resources

Push and Pull for Kids by Homeschool Pop[44]
This video explains the basic concepts of pushes and pulls.

Push and Pull for Kids by BuzzWithBee[45]
This video explains the basic concepts of push and pull. Defines the word "motion."

[44] Homeschool Pop, *Push and Pull for Kids*.
[45] BuzzWithBee, *Push and Pull for Kids | Force and Motion*.

Isaac Newton's Three Laws of Motion for Kids/Newton's Laws by Kids Learning Tube[46]
This video is more for upper grades, but good information for a teacher to have. This explains Newton's Laws using more advanced vocabulary.

Supplemental Texts on Force and Motion (all available for free to educators on Epic! Online Library)

Motion by Kay Manolis[47]

Stop and Go, Fast and Slow: Moving Objects in Different Ways by Buffy Silverman[48]

Sir Isaac Newton by Fernando Gordon[49]

Magnets Push, Magnets Pull by David A. Adler[50]

Universal Design for Learning by Reading Rockets[51]
This article provides an outline of the Universal Design for Learning principles, along with links to other resources.

Happy Birthday, Sir Isaac Newton! by SciShow for Kids[52]
This is just supplemental information about Sir Isaac Newton.

CAST Website for Universal Design for Learning[53]
This is a primary source for information about Universal Design for Learning.

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[46] Kids Learning Tube, *Issac Newton 3 Laws of Motion for Kids/Newton's Laws*.
[47] Manolis, *Motion*.
[48] Silverman, *Stop and Go, Fast and Slow*.
[49] Gordon, *Sir Isaac Newton*.
[50] Adler, *Magnets Push, Magnets Pull*.
[51] "Universal Design for Learning."
[52] SciShow Kids, *Happy Birthday, Sir Isaac Newton!*
[53] "UDL: The UDL Guidelines."

Bibliography

"About Our School." Accessed September 26, 2021. https://schools.cms.k12.nc.us/bainES/Pages/AboutOurSchool.aspx.

Adler, David A. Magnets Push, Magnets Pull. Reprint edition. Holiday House, 2018.

"Background, Facts and History." Accessed September 26, 2021. https://www.cms.k12.nc.us/communications/aboutus/Pages/default.aspx.

"Bain Elementary." Accessed September 26, 2021. https://ncreports.ondemand.sas.com/src/school?school=600314&year=2020&lng=en.

Generation Genius. "Balanced & Unbalanced Forces | Science Lesson For Kids | Grades 3-5." Accessed November 14, 2021. https://www.generationgenius.com/balanced-and-unbalanced-forces-for-kids/.

"Boulders Rocks Formation - Free Photo on Pixabay." Accessed November 11, 2021. https://pixabay.com/photos/boulders-rocks-formation-mountain-1322554/.

BuzzWithBee. Push and Pull for Kids | Force and Motion, 2020. https://www.youtube.com/watch?v=-lOyW3pEUl0.

"Charlotte-Mecklenburg Schools." In Wikipedia, June 3, 2021. https://en.wikipedia.org/w/index.php?title=Charlotte-Mecklenburg_Schools&oldid=1026565317.

"Definition of FRICTION." Accessed September 26, 2021. https://www.merriam-webster.com/dictionary/friction.

"Definition of FRICTION." Accessed November 1, 2021. https://www.merriam-webster.com/dictionary/friction.

"Definition of GRAVITY." Accessed October 30, 2021. https://www.merriam-webster.com/dictionary/gravity.

"Definition of PULL." Accessed September 26, 2021. https://www.merriam-webster.com/dictionary/pull.

"Definition of PUSH." Accessed September 26, 2021. https://www.merriam-webster.com/dictionary/push.

"Examples of Sliding Friction: What It Is in Simple Terms." Accessed November 1, 2021. https://examples.yourdictionary.com/examples-of-sliding-friction.html.

BYJUS. "Fluid Friction : Types of Friction With Detailed Explanation & Example | BYJU'S." Accessed November 11, 2021. https://byjus.com/physics/fluid-friction/.

"Free Image on Pixabay - Emoji, Smile, Sad, Emoticon, Smiley." Accessed November 14, 2021. https://pixabay.com/vectors/emoji-smile-sad-emoticon-smiley-5101944/.

"Free Images : Feather, Natural Material, Quill, Grass, Fashion Accessory, Soil, Invertebrate, Wing, Fur, Macro Photography, Balance, Rock, Wildlife 4000x2248 - Jamf5263 - 1637759 - Free Stock Photos - PxHere." Accessed November 11, 2021. https://pxhere.com/en/photo/1637759.

"Free Images : Sport, Wheel, Blue, Toy, Fitness, Sports Equipment, Yoga, Sphere, Large, Shape, Gymnastics, Inflatable, Exercise Ball, Swiss Ball 3648x2736 - - 957818 - Free Stock Photos - PxHere." Accessed November 11, 2021. https://pxhere.com/en/photo/957818.

"Geograph:: View of Skateboard Ramps in Parsloes... © Robert Lamb." Accessed November 11, 2021. https://www.geograph.org.uk/photo/6796367.

Gordon, Fernando. Sir Isaac Newton. Illustrated edition. Minneapolis, Minnesota: Abdo Publishing, 2016.

"Gravity." Accessed October 30, 2021. https://web.stanford.edu/~buzzt/gravity.html.

Homeschool Pop. Push and Pull for Kids, 2020. https://www.youtube.com/watch?v=ZLDUrPaLQWE.

"Ketchup Is Not Just a Condiment: It Is Also a Non-Newtonian Fluid - Scientific American." Accessed November 11, 2021. https://www.scientificamerican.com/article/ketchup-is-not-just-a-condiment-it-is-also-a-non-newtonian-fluid/.

Kids Learning Tube. Issac Newton 3 Laws of Motion for Kids/Newton's Laws, 2019. https://www.youtube.com/watch?v=hybtm9Ucqu8.

"K-PS2-1 Motion and Stability: Forces and Interactions | Next Generation Science Standards." Accessed November 11, 2021. https://www.nextgenscience.org/pe/k-ps2-1-motion-and-stability-forces-and-interactions.

Lalotra, Sahil. "Rolling Friction - Definition, Examples, Coefficient, Causes, Formula." BYJUS. Accessed November 1, 2021. https://byjus.com/physics/rolling-friction/.

"Law of Force and Acceleration - Newton's Second Law of Motion - Physics Video by Brightstorm." Accessed October 30, 2021. http://www.brightstorm.com/science/physics/newtons-laws-of-motion/law-of-force-and-acceleration-newtons-second-law-of-motion/.

Manolis, Kay. Motion. Illustrated edition. Minneapolis, MN: Bellwether Media, 2008.

"NC K-2 Science Essential Standards." Accessed September 26, 2021. https://www.dpi.nc.gov/media/4057/open.

Cool Kid Facts. "Newton's 3 Laws of Motion For Kids [with Examples]," March 28, 2019. https://www.coolkidfacts.com/laws-of-motion/.

Glenn Research Center | NASA. "Newton's Laws of Motion." Accessed September 26, 2021. https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/newtons-laws-of-motion/.

SciShow Kids. Happy Birthday, Sir Isaac Newton!, 2018. https://www.youtube.com/watch?v=l_HnEZf7BB4.

Silverman, Buffy. Stop and Go, Fast and Slow. New edition. Vero Beach, Fla.: Rourke Educational Media, 2011.

"Static & Kinetic Friction." Accessed November 1, 2021. http://ffden-2.phys.uaf.edu/211_fall2002.web.dir/ben_townsend/staticandkineticfriction.htm.

"The 3 Areas of Executive Function." Accessed October 30, 2021. https://www.understood.org/articles/en/types-of-executive-function-skills.

The Noun Project. "The Noun Project." Accessed November 11, 2021. https://thenounproject.com/term/ramp/169108/.

"Trouble with Flexible Thinking: Why Some Kids Only See Things One Way." Accessed October 30, 2021. https://www.understood.org/articles/en/flexible-thinking-what-you-need-to-know.

"UDL: The UDL Guidelines." Accessed October 30, 2021. https://udlguidelines.cast.org/.

"UDL: Use Multiple Tools for Construction and Composition." Accessed October 30, 2021. https://udlguidelines.cast.org/action-expression/expression-communication/construction-composition.

Reading Rockets. "Universal Design for Learning," December 2, 2019. https://www.readingrockets.org/article/universal-design-learning.

"What Is Self-Control?" Accessed October 30, 2021. https://www.understood.org/articles/en/self-control-what-it-means-for-kids.

BYJUS. "What Is Static Friction? - Definition, Examples, Laws of Static Friction." Accessed November 1, 2021. https://byjus.com/physics/static-friction/.

"What Is Universal Design for Learning (UDL)?" Accessed October 30, 2021. https://www.understood.org/articles/en/universal-design-for-learning-what-it-is-and-how-it-works.

"What Is Working Memory?" Accessed October 30, 2021. https://www.understood.org/articles/en/working-memory-what-it-is-and-how-it-works.

Endnotes