Needham Public Schools
Kindergarten
Science and Engineering Centers
Unit 3: Construction

Note to teachers: If you see any errors or broken links on this overview, the lesson plans, or the slides, please comment on the document and identify the issue so that we can fix it. We are so grateful for your collaboration!

In kindergarten, students build on early experiences observing the world around them as they continue to make observations that are more quantitative in nature and help them identify why some changes occur. In this unit, students continue to develop their observation skills, recognizing and describing what they observe in experiments with structures and pushes and pulls.

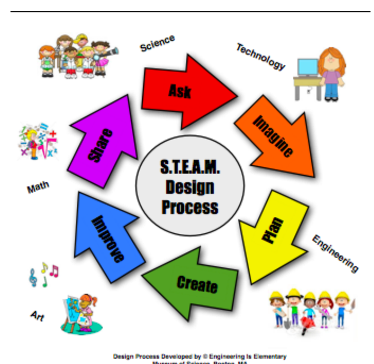
Students begin to learn to use these observations as evidence to support a claim through growing language skills. In kindergarten science, students begin to identify reasons for changes in some common phenomena, such as what makes structures stand or fall, and what makes things move.

In the kindergarten performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students begin to learn how to record their observations, predictions and results. This unit allows many opportunities for students to develop their engineering skills as they plan, construct and test structures.

Your role as the teacher is to guide students, generate curiosity, promote questioning, introduce scientific and engineering vocabulary and help synthesize ideas, and not to provide information or facts.

In this unit, the construction design process is introduced. These steps are almost exact as the NPS STEAM design process (used in grade 1-3) but the order of Imagine and Ask are reversed. The steps supported in this unit are:

Imagine: Learn about the problem, gather ideas
Ask/Research: What can we learn about problem? Finding answers using many resources (such as books and people).



Plan: Draw a diagram. Make lists of materials you will need.
Create: Follow your plan and create something. Test it out!
Improve: What works? What doesn't? What could work better? Modify your designs to make it better. Test it out!
Share: Share your ideas with others.

Connection to Unit

This unit coincides with the third unit; Construction with the following read alouds:

Week 1: *Three Little Pigs* by Paul Galdone and *Martin's Big Words* by Doreen Rappaport
Week 2: *The True Story of the Three Little Pigs* Jon Scieszka
Week 3: *House and Homes* by Ann Morris and *Homes around the world* by max morris
Week 4: *The-Night-Worker,* Kate Banks and *Dreaming up: A celebration of Building*, Christy Hale
Week 5: *How-a-House-is-Built*, Gail Gibbons
Week 6: *The Little Red Fort,* Brenda Maier and Sonia Sanchez
Week 7: *Roxaboxen* by Natalie Rosinsky
Week 8: *Dirt: the-Scoop-on-Soil,* Natalie Rosinsky

Essential questions:
- What process helps you construct structures, ideas and works of art?
- How do engineers design structures?
- What makes structures strong and stable?
- How do people use pushes and pulls?
- How can we use pushes and pulls to move structures or make them fall down?

Enduring Understandings:
- Construction can be defined as the creation of products, including physical structures and works or art, such as stories, dances, theatrical performances, or songs. The construction process can be similar across domains.
- Through using materials and interacting with them, people learn important concepts and gain skills relating to physical science, engineering and technology, and the arts.

Standards met:

Pre K-PS2-1(MA). Using evidence, discuss ideas about what is making something move the way it does and how some movements can be controlled.

PreK-PS2-2(MA). Through experience, develop awareness of factors that influence whether things stand or fall.

Clarification Statement: • Examples of factors in children's construction play include using a broad foundation when building, considering the strength of materials, and using balanced weight distribution in a block building.

K-PS2-1. Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

Clarification Statements: • Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. • Comparisons should be on different relative strengths or different directions, not both at the same time. • Non-contact pushes or pulls such as those produced by magnets are not expected. [K-PS2-2 from NGSS is not included.]

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation peopl
want to change in order to define a simple design problem that can
be solved by developing or improving an object or tool.*

K-2-ETS1-2. Generate multiple solutions to a design problem and make a drawing
(plan) to represent one or more of the solutions.

Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Overview of Centers by Week

Note: all S& E investigations for this unit take place in the Block Center and the sensory table

S & E Investigations (to take place at blocks)	S & E Investigations (to take place at Sensory Table)
• Investigation 1: Exploring size and stability- (students experiment with knocking over plastic water bottle and cups with bigger/smaller bases)	- Investigation 1*:* Exploring LEGOs- (students are given design challenges with legos/duplos and document them)

● Investigation 2: Exploring weight and stability (students experiment with knocking down empty and sand filled water bottles) ● Investigation 3: Exploring balls, ramps & how things move (open exploration) ● Investigation 4: Exploring force and how things move (students experiment with different amounts of force in knocking down water bottles) ● Investigation 5: Exploring pushes, pulls and movement (students experiment with pushing/pulling bins filled with heavy water bottles). ● Investigation 6: Designing and constructing stable structures (Children apply what they have learned from previous investigations to design and construct stable structures. They test and retest their structures, practicing the construction design process).	- Investigation 4: Scenes from the Night Worker
● In weeks 7-8: Students explore student developed questions for our School Project) which can take place in blocks and/or S & E tables ● Construction Challenges also take place in the unit- teachers challenge small groups of children to build a particular structure: the school, a building with four stories, a skyscraper, etc. (see write up in the Unit 3 Guide)	

This unit offers rich opportunity for student driven experimentation and data collection. While these lessons are outlined by week in the teacher guide, teachers should allow the class to explore students' own questions, experiments and design challenges.

Other resources are available such as building materials (lincoln logs, 3 little pigs STEM Challenge kit, kid k'nex, etc). Teachers should request these from the Science Center one week in advance of needing them.

Centers set up: This unit is structured for students to: • observe, investigate, watch, listen, and learn from experiences • engage in the world in a hands-on, physical way

• build on their natural desire to engage with the world, extending their learning about content and
• start with concrete, physical experiences, and then build to support broad, conceptual understanding of topics

What work should look and sound like during centers:
• Children asking questions and seeking answers to these questions through hands-on investigation
• Children exclaiming, making discoveries, discussing their work excitedly with each other
• Children focused on making scientific observations or design decisions

Set up:

- In this unit, science investigations will take place at the blocks center and the sensory table. There are optional activities you can add for some weeks at the Science & Engineering table. For all science and engineering centers you can decide if you want to offer another sensory table in addition to the science investigation (e.g. if you put LEGOs in the water table in the investigation you can add the sand table in another sensory table and determine how you will introduce it).
- If using water, place water table near a water source.
- If using water or sand in the sensory table, do not put on a carpeted foor

Furnishings:
1. Blocks center
2. Water table and/or large tub on a table (optional)
3. Sand table (optional)
4. Shelf or basket to store materials

Materials:
*** materials in Science Center Kit (**water bottles, cups, sand-filled water bottles, tennis balls, wooden balls, paper towel tubes, construction vehicles, ramps, plastic bins, plastic bin with rope, demolition ball set up)
* balance
• towel to mop up spills
• bucket for filling discovery table with water
• dustpan and brush to clean up sand and soil
* building toys available (lincoln logs, kid knex, etc) (request from Science Center)

* paper towel tubes, everyday objects, cardboard boxes of different sizes* (teacher provided)

[Unit 3 Pushs and Pulls supplement. Printouts]

Texts for Read aloud

Week 1: *Three Little Pigs* by Paul Galdone *Martin's Big Words*
Week 2: *The True Story of the Three Little Pigs* Jon Scieszka
Week 3: *House and Homes* by Ann Morris and *Homes around the world* by max morris
Week 4: The-Night-Worker, Kate Banks and *Dreaming up: A celebration of Building*, Christy Hale
Week 5: How-a-House-is-Built, Gail Gibbons
Week 6: *The Little Red Fort,* Brenda Maier and Sonia Sanchez
Week 7: *Roxaboxen* by Natalie Rosinsky
Week 8: *Dirt: the-Scoop-on-Soil,* Natalie Rosinsky

• informational texts for read aloud or library/listening (provided in kit):

- *Push and Pull* Big Book by Marcia Freeman
- *Sheep in a Jeep* by Nancy E. Shaw and Margot Apple
- *Oscar and Cricket* by Geoff Waring
- *Push and Pul*l by Patricia Murphy
- *Pushes and Pulls* by Sharon Coan, Teacher Created Materials

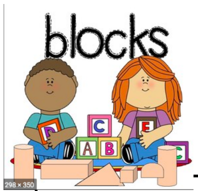
Related materials:

TEXTS: (not provided) (Pushing and Pulling by Natalie Hyde, The Way Things Move: Push and Pull by Lola M. Schaefer, The Enormous Turnip/The Gigantic Turnip (folktale) by various authors, Truck Got Stuck by Kevin Lewis and Daniel Kirt,)

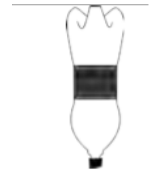
• IPAD/phone/camera for documenting student work and experiments
• writing supplies and paper
• clipboards

Other materials: These can be created by the teacher and/or in collaboration with the children, and can remain in the area all year once they are introduced and modeled.

• Investigation questions written on chart paper, with notes added from whole group discussions

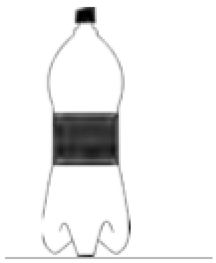
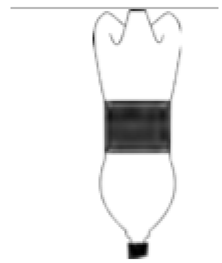


Science and Engineering
Investigation 1: Exploring size and stability



Learning Goal:	Students will be able to: - Identify several factors that make stable structures (wider bases, balanced weight distribution)
Materials:	- 8-10 plastic cups (cups with larger rims and small bases work - 8-10 plastic water bottles (16 oz) - 3 tennis balls - painters or masking tape (or other strong tape for marking floor, for teachers to delineate a testing area if they choose) - Other: paper towel tubes, everyday objects, cardboard boxes of different sizes* (teacher provided) - chart paper - pencils or crayons - 3 little pigs STEM activity (optional) 1 per (building) - Optional 4 sets of 36 cups per student for Cup Towers from SciShowKids
Science and Engineering Center Activitiy	Children roll tennis balls attempting to knock down water bottles and cups that are placed upright and upside down. They complete a whole class data chart comparing water bottles with bigger/smaller bases. Children can continue rolling balls to knock over objects adding more materials such as paper towel tubes and other everyday objects. Optional- students build tall structures with cups from SciShowKids
Guiding Questions during the center:	-Which materials were more stable? -What do you think makes the materials more or less stable? You can encourage students to act as engineers to design/build structures out of boxes or other materials with wider or smaller bases to see which is more stable. Consider taking pictures of student experiments to share during thinking and feedback.
Sharing our Research:	- What did you investigate this week in the S & E center? - What did you notice about what makes materials more stable? Display the class data chart and ask students to share observations. Guide children to think about how the size of the base of an object might make a difference in how easily the objects falls over when hit by a ball. You can introduce the idea of a hypothesis- an idea that you think might work or be true and ways to experiment… e.g. if your hypothesis is that the base has to be wider to be stable how could we test that out?
Related Standard(s):	PreK-PS2-2(MA). Through experience, develop awareness of factors that influence whether things stand or fall. Clarification Statement: • Examples of factors in children's construction play include using a broad foundation when building, considering the strength of materials, and using balanced weight distribution in a block building.
Related vocabulary:	- investigate -base - engineer - stable -hypothesis - structure - experiment

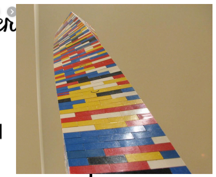
Class data sheet Investigation 1- Water Bottles

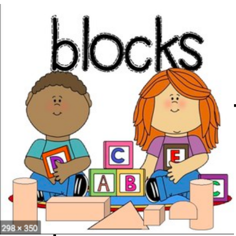
Class data sheet Investigation 1- plastic cups

S & E investigation # 2: Exploring LEGOs

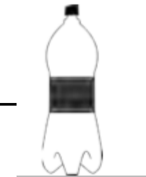


Learning Goal:	Students will be able to - Build stable structures - Document their structures
Materials:	- LEGOs - Materials for documenting (writing implements, paper, clipboards, etc)
Science and Engineering Center Activities:	Children build and document structures and/or teacher provides challenges e.g., construct a stable 3 story tower), aesthetic (e.g., construct a beautifully patterned tower; construct a realistic model of our school), or conceptual (e.g., construct a park that would be fun and safe for the 1 children in our school. Students document their structures (refer to separate introduction lesson- “Documenting Our Constructions”)
Guiding Questions during the center:	-What discoveries are you making about LEGO bricks? • What challenges are occurring? -What hypotheses do you have about solving this challenge? What ideas do you have that might work that you can test out? -How will you work together to construct the best solution to this challenge?- What process/ steps did you use to help you? - What resources do you have to help you solve this challenge? Are there any experts in the classroom who can help? Are there any books in the library? -What do you notice about the shapes and sizes of these LEGO bricks? -Where will you attach the next pieces to your structure? on top? below? on the side? -How do you know if your structure is stable? Take photographs and write notes of dialogue as children work. Video taping could also be used to document the process.
Sharing our Research:	Have students share discoveries and challenges. You can ask the class for feedback about ways to address challenges. What problems did you encounter working on this challenge? • What helped you solve these problems and solve the challenge (if you did)? How did you work like engineers improve your structures to make them more stable? Did you change or improve the bases? • What other challenges haven’t you solved that the whole group can help you with? Whole group: • What hypotheses do you have to meet these challenges? You can review how engineers are people who solve problems, such as designing stable buildings and structures. They often have to work together and change their ideas in order to solve the problem.
Related Standard(s) :	PreK-PS2-2(MA). Through experience, develop awareness of factors that influence whether things stand or fall. Clarification Statement: • Examples of factors in children’s construction play include using a broad foundation when building, considering the strength of materials, and using balanced weight distribution in a block building.
Related vocabulary	-construct - base - design -resources - weight -challenge - discoveries -materials - hypothesis -stable - engineer



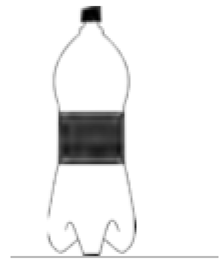
S & E investigation # 2:

Exploring weight and stability

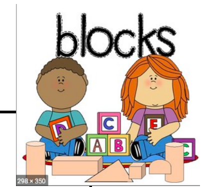


Learning Goal:	Students will be able to: - Identify how balanced weight can make a structure more stable - Experiment with building and knocking down structures
Materials:	-4-5 plastic water bottles (16 fluid ounce size) filled with sand and taped shut -4-5 empty plastic water bottles (16 fluid ounce size) -3 tennis balls -a balance (optional) -painters or masking tape painters or masking tape (or other strong tape for marking floor, for teachers to delineate a testing area if they choose) -chart paper -everyday materials such as paper towel tubes, paper cups, cardboard boxes, blocks (for further STEM exploration) -3 little pigs STEM activity (optional) - 1 provided per school
Science and Engineering Center Activities:	Children take turns setting up empty and sand filled bottles and knocking them over, in order to investigate how the **weight** of an object affects its stability. They record results on a class chart. Student can also conduct tests of stability with other everyday materials. They can consider the size of the base and weight of the object and predict how hard or easy the object will be to knock over. (e.g. build two towers one with wooden blocks and the other with light foam blocks and test which tower is more stable. Does one fall over by blowing on it? What happens if you try to move the towers?) They can weigh different objects from the classroom using the balance and compare which ones are easier to knock over.
Guiding Questions during the center:	
Sharing our Research:	Ask the children, “What did you do this week as scientists in the block center?” Revisit the focus question, “What can we do to investigate how the weight of an object affects its stability?” Have children share their data by counting the x’s in the class data chart.. Discuss why there might be more x ’s in one category (most likely the column with the empty bottles). Children can share the results of explorations with other materials.
Related Standard(s) :	PreK-PS2-2(MA). Through experience, develop awareness of factors that influence whether things stand or fall. Clarification Statement: • Examples of factors in children’s construction play include using a broad foundation when building, considering the strength of materials, and using balanced weight distribution in a block building.
Related vocabulary	-properties -investigate - stable - construct - resources -materials - weight

Class data sheet Investigation 2- Exploring weight and stability

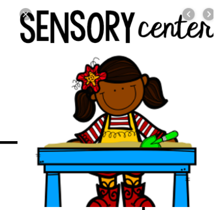
	

S & E investigation # 3: Exploring balls, ramps & how things move



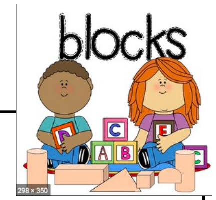
Learning Goal:	Students will be able to: -explore balls and ramps -begin to notice how use you can use balls and ramps to cause objects to move
Materials:	-ramps, assorted sizes (15) -balls, wooden (10) -tennis ball (3) -water bottles, empty -water bottles, filled with sand - *Oscar and the Cricket* by Geoff Waring (optional) - 3 little pigs problem solving STEM activity (optional) 1 per teacher
Science and Engineering Center Activities:	Students explore openly with balls and ramps. Teacher can challenge students: Can you move or knock over a light water bottle? A bottle with more weight?? Can you move the ball up and down a ramp? Can you make a maze for the balls? How could you change how we roll a ball to make it easier to move a water bottle?
Guiding Questions during the center:	- How are you using ramps and balls? - How are you able to use the balls to move the water botles? - What would happen if… (your raised/lowered the height of the ramp? Made a longer ramp, made a maze for the balls…) You can photograph or film students experiments to show during thinking and feedback.
Sharing our Research:	How did you roll the balls down the ramps? What did you notice? How did you get the balls to move the bottles? If you choose, you can read *Oscar and the Cricket* and discuss how student used a push to get the ball moving. The book also introduces the idea that all objects need a push or a pull to start moving.
Related Standard(s) :	K-PS2-1. Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. Clarification Statements: • Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. • Comparisons should be on different relative strengths or different directions, not both at the same time. • Non-contact pushes or pulls such as those produced by magnets are not expected. [K-PS2-2 from NGSS is not included.]
Related vocabulary	-weight - move - push -pull - force

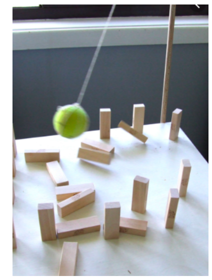
S & E Investigation # 4: Scenes from the Night Worker



Learning Goal:	Students will be able to: - Tell stories about construction and *The Night Worker*
Materials:	- sensory table filled with sand - model construction vehicles - craft popsicle sticks or small twigs - spray bottle (to moisten sand) - a dustpan and brush for sweeping sand - *The Night Worker*
Science and Engineering Center Activities:	At the the sensory table, children act out scenarios based on *The Night Worker,* using sand, model vehicles, and props
Guiding Questions during the center:	- What is your construction story? How does the story begin/continue end? - What inspired you to tell this story? - Where there any pushes and pulls in your story? You can transcribe students' stories using the children's words and/or photograph or video students working and creating scenes in the sand.
Sharing our Research:	Using and/or photos from this week's center: - Read the stories about construction and night workers to the whole group. Ask for similarities and differences between the stories and the Night Worker. Consider asking them if they noticed pushes or pulls in any of the stories. How might construction workers and construction vehicles use strong pushes or pulls to move objects?
Related Standard(s) :	K-PS2-1. Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. Clarification Statements: • Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. • Comparisons should be on different relative strengths or different directions, not both at the same time. • Non-contact pushes or pulls such as those produced by magnets are not expected. [K-PS2-2 from NGSS is not included.]
Related vocabulary:	- Construction -push -pull -force

S & E Investigation # 4: Exploring force and how things move



Learning Goal:	Students will be able to: - Identify how using more or less force affects how objects move. - Identify that a push is a type of force
Materials:	- 1 plastic water bottle filled halfway with sand - painters or masking tape - other everyday materials such as wooden unit blocks, paper towel, toilet - Ramps - Balls - Blocks - paper tubes, paper cups, plastic cups (for further exploration) - Demolition ball (optional) - *Push and Pull* big book by Marcia Freeman - Pushes and pulls sorting cut and past (optional) - [Pushes and Pulls Supplement. Printouts] (optional) - additional building toys available for use (Lincoln Logs, Fiddlesticks, Marble runs, Kid K'nex) by request  demolition ball set up
Science and Engineering Center Activities:	Children roll tennis balls with different force in attempt to move a water bottle, in order to investigate the f**orce** of a ball affect how it can move a water bottle. They record their data on the class data chart. Children can experiment with knocking down the towers using the different balls and ramps. Children can continue experimenting by using the ramps in order to get the balls to move with more force (thereby making them go faster and have more force). Children will not record this data on the chart, but encourage them to create their own charts to record data from these child-directed experiments. Children might build a tower using cardboard boxes, paper towel tubes paper cups, bowls, etc. or a tower using wooden blocks. You can also put out the push and pull sorting cards at the S & E center.
Guiding Questions during the center:	Did you record data about your experiment on the class chart? What do you observe? What happens when you use more force? What are you wondering? What other experiments would you like to try with these different forces? How could you record data about your experiment? Is there a way could you use forceful pull to knock down towers? (You can show students the demolition ball set up and ask if they use that to knock water bottle or other objects down.) You can photograph or film students experiments to show during thinking and feedback.
Sharing our Research:	- How were you able to knock down the bottles using pushes? Pulls? - What do you notice about our class data? - What other experiments did you try? - Read P*ush and Pull* big book and ask students- when did they see a push? Pull? Review how when students use a stronger push or pull, they are using more force.
Related Standard(s) :	K-PS2-1. Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. Clarification Statements: • Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. • Comparisons should be on different relative strengths or different directions, not both at the same time. • Non-contact pushes or pulls such as those produced by magnets are not expected. [K-PS2-2 from NGSS is not included.]
Related vocabulary:	-observe - push -pull - force -construction -experiment

S & E investigation # 4: (class chart for data collection)

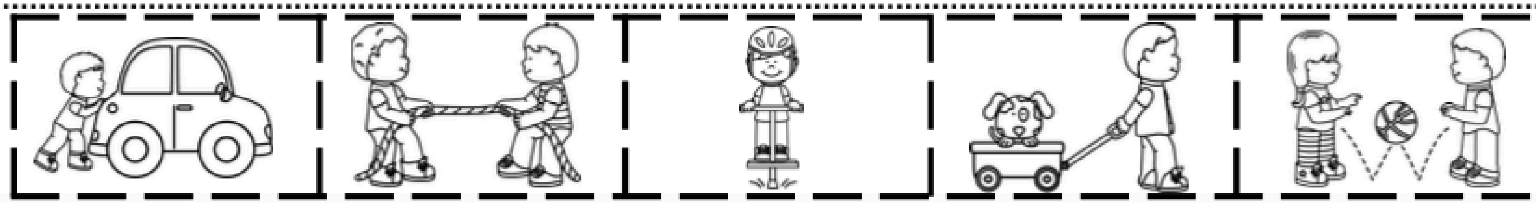
S-L-O-W and gentle roll	Fast and Forceful roll

Push or Pull?

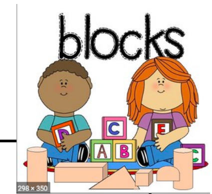
Name__________________

Cut and sort the action pictures that show either a push or a pull.

push	pull



S& E investigation #5: Exploring pushes, pulls and movement



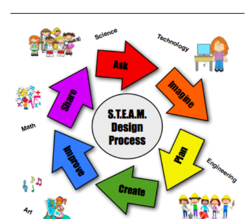
Learning Goal:	Students will be able to: - Show how a push or pull can be used to cause a basket to move - Show how a stronger push or pull is needed to move an object
Materials:	- Plastic water bottles, empty (10-20) - Plastic water bottles, filled with sand (20) - White plastic bins - White plastic bin, with rope for pulling (1) - Tape - Other objects from the room - *Push and Pull* big book by Marcia Freeman - Ramps (optional) - Balls (optional) - Laundry baskets(2) * teacher provided (optional) - Extension- students look through books and put sticky notes to identify pushes and pulls - Extension- Generation Genius Video Pushes and Pulls - User name: sciencecenter@needham.k12.ma.us password: Sciencecenter
Science and Engineering Center Activities:	Students explore how many seconds it will take to push and pull a bin filled with heavy water bottles across the floor. They record their data on the class data chart. Students can explore how fast they can push/pull different items. If you choose, you can add in balls and ramps and challenge students to use pushes and pulls to get balls to move.
Guiding Questions during the center:	- What do you notice? Which is faster? Pushing or pulling? Why do you think so? What would happen if…. You used something really heavy/ really light. * How could you experiment to find out? - You can photograph or film students experiments to show during thinking and feedback.
Sharing our Research:	- How were you able to move the baskets with pushes and pulls? - What do you notice about our class data? - What other experiments did you try? - Read or re- read *Push and Pull* big book and ask students to connect to the ideas in the book- how do we use pushes and pulls to move things? Can you move anything without pushes or pulls? You can also connect *How a House is Built*- how do people use pushes and pulls to move objects to construct houses? Possible extension: As a whole group, you can lead a laundry basket "race:" Students pair up and make some predictions on how many seconds it will take them to push and pull their classmates across the carpet. See this Lesson plan for more instructions You can also show the Generation Genius video as a review of pushes and pulls (requires password and login sciencecenter@needham.k12.ma.us password: Sciencecenter)
Related Standard(s) :	K-PS2-1. Compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. Clarification Statements: • Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. • Comparisons should be on different relative strengths or different directions,

	not both at the same time. • Non-contact pushes or pulls such as those produced by magnets are not expected. [K-PS2-2 from NGSS is not included.]
Related vocabulary:	-experiment - push - pull -force -weight

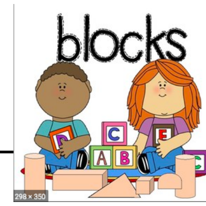
S & E investigation # 4: (class chart for data collection)

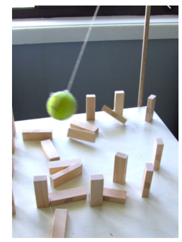
Pushes and Pulls

How many seconds did it take to **pull** the basket?	How many seconds did it take to **push** the basket?



S& E investigation #6 Designing and constructing stable structures



Learning Goal:	Students will be able to: -apply what they know about structures, pushes and pulls to design, construct and test stable structures -use steps of the construction design process to plan, create, test and share their structures
Materials:	- Tennis ball - Baseball - 20 plastic water bottles filled halfway with sand - 10 empty plastic water bottle - 50 plastic cups - paper towel tubes and toilet paper tubes - demolition ball set up - construction design process chart (refer to Unit 3 Introduction Documents) - planning sheets for students - optional: the engineering song 
Science and Engineering Center Activities:	How can we design a structure that is difficult to knock down? Children work collaboratively to create structures using the materials provided. They test the structures for stability and document their structures. Students should be encouraged to revise and improve their structures. They can also document their structures for sharing in thinking and feedback.
Guiding Questions during the center:	Which materials will you choose to construct your structure?• Will your structure have a wide or narrow base? • How will you test for stability? How could you use a push or pull to test your structure? Did your structure withstand the stability test? If not, what will you do to improve your structure? • How can you sketch this structure to remember it? Encourage students to label the base.
Sharing our Research:	Invite groups to share their structures and documentation. Ask the groups to describe how theyworked as engineers to test for stability and how they improved their structures to make them more stable. Compare the structures. Which have wider bases? Which are heavier? How did you use a push or a pull to knock down Together, based on the findings of this and the prior Investigations, create a class list (use shared writing or you can take dictation) of strategies for building stable structures. Strategies might include building a wide base, using heavier materials, or building a structure that stands straight. If you choose, you can teach them the engineering song and the associated movements.
Related Standard(s) :	K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change in order to define a simple design problem that can be solved by developing or improving an object or tool.* K-2-ETS1-2. Generate multiple solutions to a design problem and make a drawing (plan) to represent one or more of the solutions.
Related vocabulary	- stable -push - weight -engineer - base -pull -force -design

End of Unit Survey!	Please take a few minutes to complete this end of unit survey! Your responses are greatly appreciated!

"The Engineering Song" (To the tune of "The Farmer in the Dell")

Chorus: (To the tune of "Farmer in the Dell")	**Suggested full body movements:**
We are engineers. We are engineers! We can solve problems because We are engineers!	(one thumb in to chest) (second thumb in to chest) (march in place) (both thumbs in to chest)
Verse: (follow along using poster)	**Suggested full body movements:**
First we Explore, Then we Create, Improve to make it better 'Cause engineers are great!	(look through pretend magnifying glass) (wave hands in front of body) (wiggle fingers high over head) (march in place then jump!)

Background Knowledge for Teachers

Critical teaching ideas

- A structure which will not topple over easily is said to be stable.
- It is more difficult to make a structure with a wide base topple over so, the wider the base therefore, the more stable the structure.
- Structures with balanced weight will be less likely to topple over.
- The shape and the material used to built a structure determine its stability.
- We can describe how something moves by saying how fast it is going and what sort of path it takes.
- The way to start an object moving or change how it is moving is to give it a push or a pull.
- At this level it is appropriate to encourage students to use the terms ‘push’ and ‘pull’ for a range of situations in which things are moving or not moving, and where the direction or speed of movement is changing. They need experiences that help them understand that to change how something is moving it needs to be given a push or a pull.

Strong/Stable Structures from www.scientistsinschool.ca

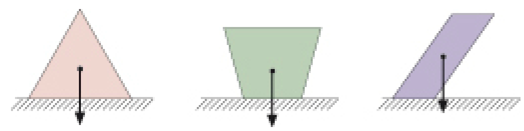
Have you asked your students if they made or used a structure today? Perhaps they created a bridge by laying a branch across a stream or rode their bicycle to get to school. We use structures everyday. They surround us in our community but we may not always take notice of them. Did you notice that bridge on the drive to school or the hydro towers nearby? Have you ever wondered if the bridge that you cross is really strong and stable? What went into designing and constructing this essential structure? There are many professionals involved in designing and building structures such as engineers, architects and builders. They play an important role in making a structure safe and useful for us.

Structures A **structure** is an object with a definite size and shape that is constructed for a specific function or purpose. In order to serve its purpose, the structure must be strong, stable and it must be able to hold a **load.** If a structure is going to be useful, then it must be able to withstand forces. There are many types of structures that are found in nature such as mountains, bee hives and icebergs. There are also human made structures such as towers, flag poles and automobiles.

STABILITY

Stability is the capacity of a structure to remain upright and not tip over. Its centre of gravity must be centred over its base.

If the centre of gravity is centred in the object and close to the ground, the structure will be more stable.



Of the three figures, the most stable is on the left, and the least stable is on the right.

Materials Each material used in a structure has specific characteristics and properties. **Engineers** will look for materials with certain properties to ensure their structure meets the requirements of its purpose. Structural strength is one of the most important properties to consider. The strength of a material can be further improved by layering, braiding, twisting and changing the shape of the material.

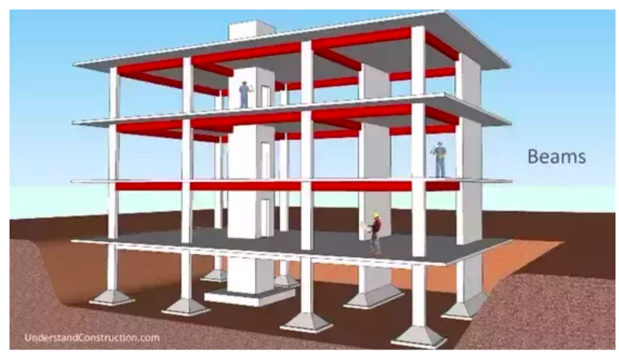
Another way to increase strength is to combine two or more different materials to create a stronger composite material. Steel bars can be used within concrete to reinforce it, resulting in a stronger building material. Carbon or glass fibres can be combined with resin to create a strong yet lightweight composite material. These fibre-reinforced polymers are commonly used in high performance automobiles and boats as well as in the aerospace and aviation industries. Other **properties** that might be considered when making a structure for a specific purpose are flexibility, absorbency, durability and thermal resistance. A combination of materials with different properties can also be used to improve a structure's usefulness. For example, a roof has many layers to fulfill its purpose of providing shelter, being weather resistant and supporting a load. The materials utilized in a roof which make it strong, durable and water repellent include a wood frame, plywood, tar paper and shingles. The way different materials are used in construction and the design of objects will ultimately determine the strength and effectiveness of the structure.

Forces and structures When a load is applied to a structure, there are forces that act upon the structure:
● a structure is under tension when there are pulling or stretching forces acting on it (e.g. stretching a rubber band);
● a structure is under compression when there are pushing or squeezing forces acting on it (e.g. squishing a sponge).

The materials used in structures will resist tension and compression differently depending on their characteristics. Wood, commonly used in construction, is a good example of a material that can resist both forces. A material that is particularly strong at resisting tension due to its elastic properties is steel. Concrete is strong at resisting compression but not tension as it is non-elastic.

By combining materials, engineers are able to change their **properties**. The use of steel within concrete can improve the tensile and compressive properties of these materials.

Strength and Stability Strength is the ability to support a load and withstand forces. Stability is the ability to maintain balance without snapping and collapsing. The strength and stability of a structure is dependent on whether it has been designed to withstand forces by transferring them from weak to strong areas. Engineers employ many different structural design techniques to improve strength and stability.



These can include:

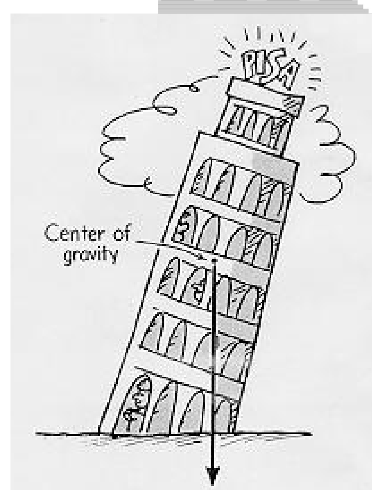
● beam – a structural component that is used to support a load across its span which resists bending or the tension and compression forces within it (e.g. reinforced concrete beam).

● truss – a structural component that uses triangles (a strong, stable shape) to bear large loads and prevent deformation of the structure.

● arch – a semi circular shape that resists compression by transferring forces to the supports on each side of the arch, called abutments (e.g. bridge).

● column – a structural component that resists compression and supports the weight above (e.g. Roman Parthenon).

● centre of gravity – the place in a structure where the weight is evenly dispersed and all sides are in balance. This is an important element to locate in a structure to ensure the structure is stable and able to withstand forces. The centre of gravity can be shifted lower by building a wide and solid base (e.g. skyscraper to withstand strong winds).



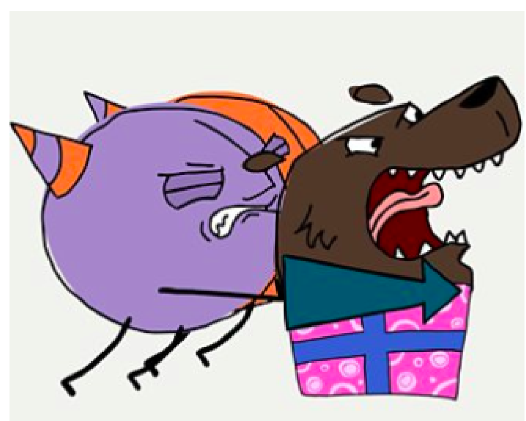
Many of these techniques were utilized in ancient civilizations as early as 2000 years ago. Stone arch bridges were built without mortar and many still stand today. As time progressed, engineers have applied new techniques to build larger structures. Skyscrapers were made possible by two inventions: the use of steel frames in construction in addition to walls for support; and the elevator which was first built in New York in 1857. The father of the skyscraper was the original 10-storey Home Insurance Building in Chicago built in 1884. It was the first design to use skeleton or steel frame technology. Today, we continue to push the limits with modern complex structures that either span longer distances or extend as larger and taller structures.

The world's longest bridge, Akashi Kaikyo Bridge in Japan, is a suspension bridge completed in 1998. It has a span of 1990 m (6530 ft) and is supported by steel cables anchored to concrete towers.

Forces

Forces are just pushes and pulls in a particular direction.

Forces are shown by arrows in diagrams. The direction of the arrow shows the direction in which the force is acting. The bigger the arrow, the bigger the force.



Forces are pushes or pulls. They are measured in newtons.

Image Credit: BBC Bitesize

Balanced forces

If two forces are balanced, it means the forces are the same size but are acting in opposite directions.

If two balanced forces are acting on an object, that object will not change its motion. If it is still, the object will stay still or if it is moving, it will continue moving in the same direction and at the same speed.

Unbalanced forces

When two forces acting on an object are not equal in size, we say that they are unbalanced forces. Unbalanced forces do change the way something is moving.

They can make objects start to move, speed up, slow down or change direction.

Construction/Design Process

We live in designed societies. The buildings and structures are all products of engineering and design. **Engineers** are people who define problems and design solutions, using a process called the Engineering Design Process. Just as there is no single linear scientific methods, there is no singular design process. Design processes often follow a particular path, or cycle, in which engineers conduct research to better define a problem, plan and make a design solution, and then test that solution and then work to improve their design. While it is often represented in steps, these steps can be nonlinear, with engineers moving back and forth between steps as needed.

In Needham Public Schools, we refer to this as the STEAM Design Process (used in grades 1-3)

In this unit, the steps are almost exact as the STEAM design process, but the order of Imagine and Ask are reversed. The steps supported in this unit are:

Imagine: Learn about the problem, gather ideas
Ask/Research: What can we learn about problem? Finding answers using many resources (such as books and people).
Plan: Draw a diagram. Make lists of materials you will need.
Create: Follow your plan and create something. Test it out!
Improve: What works? What doesn't? What could work better? Modify your designs to make it better. Test it out!
Share: Share your ideas with others.