Designing Structures for Earthquake Prone Areas

Grade(s): Kindergarten
Lesson Duration: 4 Days
Course Name(s): Engineering Design Challenge
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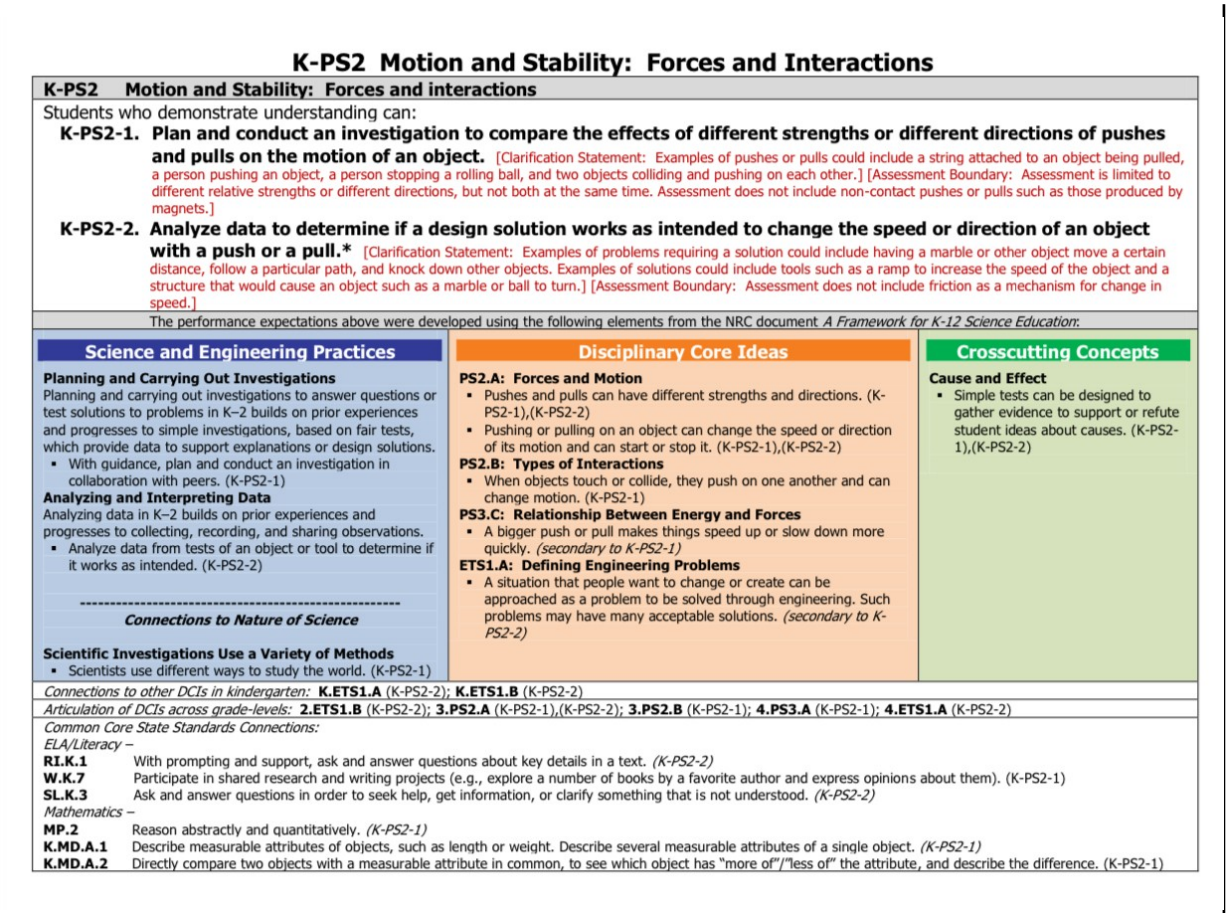
BIG IDEAS

After spending two days learning about the lithosphere and earthquakes, students will use their knowledge of force and mobility to design a structure that will withstand varying levels of “shakes.”

EDUCATION STANDARDS



K-PS2 Motion and Stability: Forces and Interactions

K-PS2 Motion and Stability: Forces and interactions

Students who demonstrate understanding can:

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. [Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]

K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.* [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- With guidance, plan and conduct an investigation in collaboration with peers. (K-PS2-1)

Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Scientists use different ways to study the world. (K-PS2-1)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2)

PS2.B: Types of Interactions

- When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

PS3.C: Relationship Between Energy and Forces

- A bigger push or pull makes things speed up or slow down more quickly. *(secondary to K-PS2-1)*

ETS1.A: Defining Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary to K-PS2-2)*

Crosscutting Concepts

Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (K-PS2-1),(K-PS2-2)

Connections to other DCIs in kindergarten: **K.ETS1.A** (K-PS2-2); **K.ETS1.B** (K-PS2-2)

Articulation of DCIs across grade-levels: **2.ETS1.B** (K-PS2-2); **3.PS2.A** (K-PS2-1),(K-PS2-2); **3.PS2.B** (K-PS2-1); **4.PS3.A** (K-PS2-1); **4.ETS1.A** (K-PS2-2)

Common Core State Standards Connections:

ELA/Literacy –

RI.K.1 With prompting and support, ask and answer questions about key details in a text. *(K-PS2-2)*

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS2-1)

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood. *(K-PS2-2)*

Mathematics –

MP.2 Reason abstractly and quantitatively. *(K-PS2-1)*

K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. *(K-PS2-1)*

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS2-1)

Common Core State Standards:

CCSS.MATH.CONTENT.K.MD.A.1

Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

CCSS.MATH.CONTENT.K.MD.A.2

Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child as taller/shorter*.

MEASURABLE STUDENT LEARNING OBJECTIVES

Students will be able to:

- Use descriptive language (more of/less of) to articulate the differences between the two objects being compared.
- Investigate how different strengths of pushes and pulls affect motion.
- Identify the strengths of pushes and pulls to design a structure that can withstand

MATERIALS NEEDED

- Graham crackers
- Frosting
- Sugar wafer cookies
- Legos
- Shake Table (1 per group, pre-assembled)
    - 2 14”X14” plexiglass
    - 4 rubber balls
    - 4 extra large rubber bands
- Data collection sheet
- Pencils
- Science Journal App to measure “shakes”
- NASA resources:
    - Latest Earthquakes
    - What is an Earthquake?
    - Earth Observatory Image of the Day
    - Surface Changes
    - Video-What are plate tectonics
    - Continents Break and Collide

ENGAGING CONTEXT/PHENOMENON

Video: Continents Break and Collide

Students will be shown the silent video that begins with Pangea beaking apart and colliding with other continents that formed. This will be shown with no explanation and is meant to get students thinking and questioning.

DATA INTEGRATION

Students will be collecting their own data with their structure design. The use of this data will guide and inform their improvements of their structures. Students will view images of land before and after earthquakes to visually see the damage that comes with the movement of land.

TEACHER BACKGROUND KNOWLEDGE

Teacher should have a foundational understanding of what earthquakes are and their basic causes. The teacher should be able to explain that earthquakes occur when the Earth's surface shakes due to movements of tectonic plates, using simple language and relatable analogies, such as comparing the Earth to a puzzle that can shift and move.

DIFFERENTIATION OF INSTRUCTION

To accommodate for English Language and SPED learners, use the following differentiation strategies:

Use of visuals and non-linguistic representations of key concepts and vocabulary will be used and referenced throughout the lesson. Students will be introduced to key vocabulary at the beginning of the lesson, picture sorts or Frayer Models for vocabulary will be utilized. Use of small groups and one-on-one support will be incorporated during the planning and building stage of the 3D structure. Sentence frames and word banks (with pictures) will be made available.

To accommodate Gifted Learners, the following differentiation strategies could be used:

Allow students to research other planets such as Mars and use data from NASA to build a structure meant for Mars. Students can also create a rescue and rebuilding plan for the aftermath of an earthquake. Students can present their project to other classes, parents and/or other school staff using technology (Google slides).

REAL-WORLD CONNECTIONS FOR STUDENTS

Learning about why and how earthquakes happen helps people understand why it's important to be prepared and safe. This includes knowing what to do during an earthquake and having a plan for emergencies. When communities learn about earthquakes, it encourages people to take part in safety drills and preparation activities. Also, studying earthquakes helps people understand how the Earth works, which makes them appreciate the environment and the need to take care of it. Overall, this knowledge not only helps keep individuals safe but also encourages everyone to be ready for disasters, support their communities, and care for the planet in their daily lives.

POSSIBLE PRIOR or MISCONCEPTIONS

Possible misconceptions may be that students believe that all earthquakes a destructive, or that the ground opens up. Students may think that earthquakes only happen is specific areas or that they can be predicted.

LESSON PROCEDURE

5E	**Details of 5E Lesson Implementation** *(Visit BSCS to learn more about the 5E instructional model)*
Engage	**Lesson Objective** • Students will be able to Investigate how different strengths of pushes and pulls affect motion. **Standards Addressed** 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. **Materials & Resources** Continents Break and Collide

	Video-What are plate tectonics What is an Earthquake? **Procedure:** • Show Continents Break and Collide • Have students think about what they watched and illustrate on a sticky note. Students will pair up with their partner and explain what they think they saw. Students will share with the class and teacher will identify any similarities and differing thoughts. • Teacher will explain what the video was about and introduce the topic of earthquakes and plate tectonics Video-What are plate tectonics, introducing vocabulary with non-linguistic representations of each. • Students will explore What is an Earthquake? **Formative/Summative Assessments** Academic discourse through partner talk Students illustrations and labeling. **Modifications** Anchor charts, sentence frames, non-linguistic representations of vocabulary: earthquake, plate tectonics, lithosphere, crust, layers, continental drift.
Explore	**Lesson Objective** Students will be able to: • Investigate how different strengths of pushes and pulls affect motion. • Identify the strengths of pushes and pulls to design a structure that can withstand **Standards Addressed** 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. **Materials & Resources** Graham crackers Frosting Construction paper Sugar wafer cookies

	Procedure: • Students will build a plate tectonic model with graham crackers and frosting • Students will place frosting on the edged of two graham crackers and balance sugar wafers on top of the crackers. • Working in partners, each student will push the graham crackers together. • Students will illustrate and label what happened. **Formative/Summative Assessments** Academic discourse through partner talk Students illustrations and labeling. **Modifications** Students will have access to anchor charts, sentence frames. Students who need one-on-one support with be paired with teacher.
Explain	**Lesson Objective** Students will be able to: • Use descriptive language (more of/less of) to articulate the differences between the two objects being compared. • Investigate how different strengths of pushes and pulls affect motion. • Identify the strengths of pushes and pulls to design a structure that can withstand **Standards Addressed** 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 **Materials & Resources** Earth Observatory Image of the Day Surface Changes **Procedure:** Students will use their knowledge of force and mobility to describe what they see in Earth Observatory Image of the Day and Surface Changes. They will connect the aftermath of earthquakes and the environment. • Students will illustrate and label what they think is happening in the image

	• Students will discuss with partner Ask students how shelter is and can be affected by earthquakes and the movement of earth. Discuss the importance of building structures that can withstand earthquakes. Explain that engineers design buildings to be strong and flexible. Introduce the concept of "shakes" by simulating an earthquake using a shake table (a simple device to create motion). Explain how different strengths of shakes can affect buildings. **Formative/Summative Assessments** Academic discourse through partner talk Students illustrations and labeling. **Modifications** Students will have access to anchor charts, sentence frames. Students who need one-on-one support with be paired with teacher.
Elaborate	**Lesson Objective** Students will be able to: • Use descriptive language (more of/less of) to articulate the differences between the two objects being compared. • Investigate how different strengths of pushes and pulls affect motion. • Identify the strengths of pushes and pulls to design a structure that can withstand **Standards Addressed** 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 CCSS.MATH.CONTENT.K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. CCSS.MATH.CONTENT.K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child as taller/shorter*.

	Materials & Resources
	
	• Legos
	• Shake Table (1 per group, pre-assembled)
	  o 2 14”X14” plexiglass
	  o 4 rubber balls
	  o 4 extra large rubber bands
	• Data collection sheet
	• Pencils
	• Science Journal App to measure “shakes”
	
	Procedure:
	
	In small groups, students will design and build their own structures using the engineering design process.
	
	• Students will build a structure out of legos. Groups will build 4 structures: 1. Tall/wide base 2. Short/wide base 3. Tall/narrow base 4. Short/narrow base
	• Students will test their structures on the Shake Table at 1cm, 3cm and 5cm
	• Prompt students to analyze their designs and discuss which structure worked and which didn’t. Ask guiding questions to help them think critically about their designs.
	• Which structure stood up to a stronger shake?
	• Why did _____ structure withstand the shake better?
	• Are there any attributes that can be combined to make a superior structure?
	
	Formative/Summative Assessments
	
	Academic discourse through partner talk
	
	Students illustrations and labeling in Engineering Notebook.
	
	Modifications
	Students needing additional support will be grouped with teacher. Anchor charts will be displayed as well as sentence frames. Teacher will model each step of the Engineering Design Process.

Evaluate	**Lesson Objective** Students will be able to: • Use descriptive language (more of/less of, longer/shorter) to articulate the differences between the two objects being compared.

- Investigate how different strengths of pushes and pulls affect motion.
- Identify the strengths of pushes and pulls to design a structure that can withstand

Standards Addressed

CCSS.MATH.CONTENT.K.MD.A.1

Describe measurable attributes of objects, such as length or weight.

Describe several measurable attributes of a single object.

CCSS.MATH.CONTENT.K.MD.A.2

Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child as taller/shorter*.

Materials & Resources

- Paper
- Pencil
- Crayons

Procedure:

- Have students describe the measurable attributes of their structures (length) and compare them to see which structure was the tallest/widest base.

  “Structure _____ is taller than structure _____.” “The structure with the _____ base was the strongest.” “The structures that is the _____ fell.”

- Students will illustrate and label their successful structure to present.
- Students will present their structures to the class, explaining how they designed them to withstand earthquakes and what they learned from the testing process.

Formative/Summative Assessments

Academic discourse through partner talk and presentations

Students illustrations and labeling.

Modifications

Students needing additional support will be grouped with teacher. Anchor charts will be displayed as well as sentence frames.

REFERENCES

Data, M. N. (n.d.). *What are Tectonic Plates? | My NASA Data*. My NASA Data. https://mynasadata.larc.nasa.gov/mini-lessonactivity/what-are-tectonic-plates

NASA Earth Observatory. (n.d.). *NASA Earth Observatory - Home*. https://earthobservatory.nasa.gov/

NASA maps surface changes from California quakes. (n.d.). NASA Jet Propulsion Laboratory (JPL). https://www.jpl.nasa.gov/news/nasa-maps-surface-changes-from-california-quakes/

What is an earthquake? | NASA Space Place – NASA Science for Kids. (n.d.). https://spaceplace.nasa.gov/earthquakes/en/