Unit: Earth

Lesson 3 How Are Force, Friction, and Earthquakes Interrelated?

Enduring Value:	**Essential Question(s):**	**National Science Education Standards (NSES, 1996)**
Stability and Change	Why do we call the Earth dynamic?	Content: Earth Science K-4 Properties of earth materials 5-8 Transfer of energy Properties and changes of properties in matter

Engage and Increase Background Knowledge:

1. Have the class watch a short video on plate tectonics including both earthquakes and volcanoes. The connection between convection and plate movement is made stronger in this lesson, building on what was learned in Lesson 2. Be sure to include strike-slip faults like the San Andreas in California.
   Resource: http://www.youtube.com/watch?v=ZxPTLmg0ZCw
2. Tell students that they are going to design an experiment that simulates a strike-slip earthquake.
   Teacher Resource: www.iris.edu/hq/files/.../1/EarthquakeMachine_Background.pdf
3. Students may choose from selected materials or their teacher can give the materials to student groups. The materials include rough sandpaper, one block of wood with a nail pounded in it toward one end, a meter stick, and a large rubber band.
4. The following experiment will increase the student's understanding of slip-strike boundaries, friction, constant force, and earthquakes.
5. Read this question to the students: *How can we create a model of a strike-slip boundary?* Then share and describe each of the materials. (See #3 above), and then ask students to think about ideas while they watch this video:
   http://wn.com/Strike---slip_fault
6. While watching the video ask students to think about what type of model they might create (i.e., a three-dimensional representation on a smaller scale). In order to increase understanding, discuss ideas and the conceptual understanding between these short videos and others that can be used as needed supports.
   http://www.pbs.org/wgbh/nova/earth/vernon-earthquakes.html;
   http://wn.com/Strike-slip_faulthttp://wn.com/Strike-slip_fault; http://wn.com/Strike-slip_fault; http://wn.com/Strike-slip_fault
7. Brainstorm experimental procedures with students using the equipment. Ask students questions such as:

- *What would the sand paper represent in an earthquake?*
- *What would the block with the nail in it represent?*
- *What is the purpose of the rubber band?*

8. Bring students to an understanding at this time that links the friction between the plates in the videos with the wooden block moving across the sandpaper.

At this point pass out a lab sheet contain the following:

Question: *How do we create a model for earthquakes?*

Hypothesis: If we create a model of an earthquake, then we can learn more about earthquakes because we can experience them on a smaller scale.

Procedure:

Students suggest procedures guided by the teacher as needed.

Pros and Cons

The teacher and the class will decide on a few experimental procedures and discuss the pros and cons of each.

Group Work:

Small groups will be created based on the students' interests. The students will experiment as the teacher circulates and asks questions that support understanding. Students will run experiments and collect data.

Example Data Table:

	Trial 1 (cm*)	**Trial 2 (cm*)**	**Trial 3 (cm*)**	**Average**
Lightest Sand Paper				
Medium Sandpaper				
Roughest Sandpaper				

Data Analysis:

Conclusion:

Sources of Error:

*Refers to the number of centimeters that the block travels once the force of the pulled rubber band overcomes the friction force of the sandpaper.

9. During the scaffolding of this experiment, the teacher can use questions to bring about understanding of the following concepts using Geology4Kids at http://www.geography4kids.com/files/earth_intro.html
   NOTE: For older students include information on S waves, P waves, and how energy is transferred during an earthquake and how this energy can cause damage to buildings and people.
   - Tectonics
   - Faulting
   - Earthquakes

In addition, use age-appropriate materials to include information on force, constant force, and friction force.

- Introduce the students to the understanding that they are exploring a mechanical model of a strike-slip fault in order to learn about how energy is stored elastically in rocks and released suddenly as an earthquake.
- Relate seismic waves to earthquakes. Seismic waves are waves in the Earth's crust that cause damage on the surface due to crustal motion.
- Extend the lesson to include the creation of a design for an earthquake-resistant building. Apply their knowledge along with research and testing as a part of their investigation. Include information on structural geology.

NOTE: For younger students, the teacher can demonstrate the experiments of their choice and then support each group as needed while they run the experiments.

Materials:
Internet, projector, wood blocks with small nails pounded in one end of them, large rubber bands, sandpaper of different roughness, meter sticks, poster paper or white boards, markers
Allow time for students to bring in materials from home as per the experimental procedures discussed above.

Explore (Investigate):

1. Students use the materials described above to **explore earthquake movement**.
2. Using the rubric to support success, students investigate with the teacher scaffolding learning as needed.
3. Using the rubric to support success, students work in collaborative groups to create a report to present to the class. The teacher uses questioning to move students forward.

Get Ready to Present:
Using the rubric to support success, the students work in collaborative groups to create reports to present to the class. The reports will be on whiteboards or poster paper and include experimental design and data, the Big Idea, and the Evidence from their experiments that supports the Big Idea. Scaffold and support students as needed.

Present:
Students self-grade and hand in the rubric. Student groups present and the audience asks questions, while each student writes a response for each presentation. This *Audience Response Sheet* will be handed in as part of the project.

Build Class Consensus of the Big Idea to Post in the Classroom:
Facilitate discussion with students to determine a class consensus about earthquake movement. See example ***Student Group Big Idea*** and ***Example Class Consensus*** below*. Does this consensus affect the earlier one or stand on its own?* Have students discuss and determine this.

STEM Vocabulary:
convection current
earthquake
pattern
movement
constant force

Example Group Presentation:

1. Display experimental data and diagrams that clearly illustrate and label the experiment(s).
2. Student **Big Idea:** *The rougher the sandpaper the larger the earthquake.*
3. Evidence: Diagram illustrating the set up that worked versus ones that did not.

Example Class Consensus:
Convection Currents cause plate movement and that causes earthquakes.

Connections:
plate movement
subduction zones
forces
plate boundaries
strike-slip boundaries
dynamic Earth