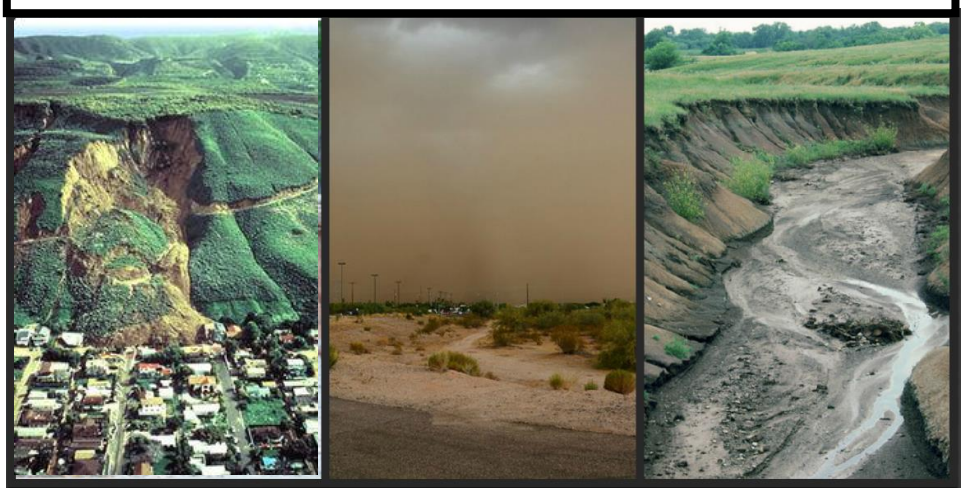
LAUSD Elementary Engineering

STOP THE PROBLEM OF WIND AND WATER EROSION CHALLENGE

Fourth Grade - Earth Science



PURPOSE:

IN THE <u>STOP THE PROBLEM OF WIND AND WATER EROSION CHALLENGE,</u>

STUDENTS WILL:

- Plan and create a solution to the erosion problem using the Engineering Design Process (EDP)
- Exhibit understanding of relevant science content/concepts
- Construct relevant questions
- Use appropriate tools and materials to complete task
- Determine effectiveness of their design
- Answer the Focus Question: <u>How can you reduce the effects of wind and rain erosion on a mountain community?</u>

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

4-ESS2-1. **Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.** [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [*Assessment Boundary: Assessment is limited to a single form of weathering or erosion.*]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**ESS2.A: Earth Materials and Systems** • Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. **ESS2.E: Biogeology** • Living things affect the physical characteristics of their regions.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change.

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels:
2.ESS1.C ; **2.ESS2.A** ; **5.ESS2.A**

Common Core State Standards Connections:

ELA/Literacy -

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS2-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. (4-ESS2-1)

MP.4 Model with mathematics. (4-ESS2-1)

MP.5 Use appropriate tools strategically. (4-ESS2-1)

4.MD.A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *(4-ESS2-1)*

4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. *(4-ESS2-1)*

3-5-ETS1 Engineering Design

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Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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

Asking Questions and Defining Problems
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Crosscutting Concepts

Influence of Engineering, Technology, and Science on Society and the Natural World

- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Connections to 3-5-ETS1.A: Defining and Delimiting Engineering Problems include:
Fourth Grade: 4-PS3-4

Connections to 3-5-ETS1.B: Designing Solutions to Engineering Problems include:
Fourth Grade: 4-ESS3-2

Connections to 3-5-ETS1.C: Optimizing the Design Solution include:
Fourth Grade: 4-PS4-3

Articulation of DCIs across grade-bands: **K-2.ETS1.A** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **K-2.ETS1.B** (3-5-ETS1-2); **K-2.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.A** (3-5-ETS1-1); **MS.ETS1.B** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3)

Common Core State Standards Connections:

ELA/Literacy –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(3-5-ETS1-2)*

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(3-5-ETS1-2)*

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-1),(3-5-ETS1-3)*

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-1),(3-5-ETS1-3)*

Mathematics –

MP.2 Reason abstractly and quantitatively. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*

MP.4 Model with mathematics. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*

MP.5 Use appropriate tools strategically. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*

3-5.OA Operations and Algebraic Thinking *(3-5-ETS1-1),(3-5-ETS1-2)*

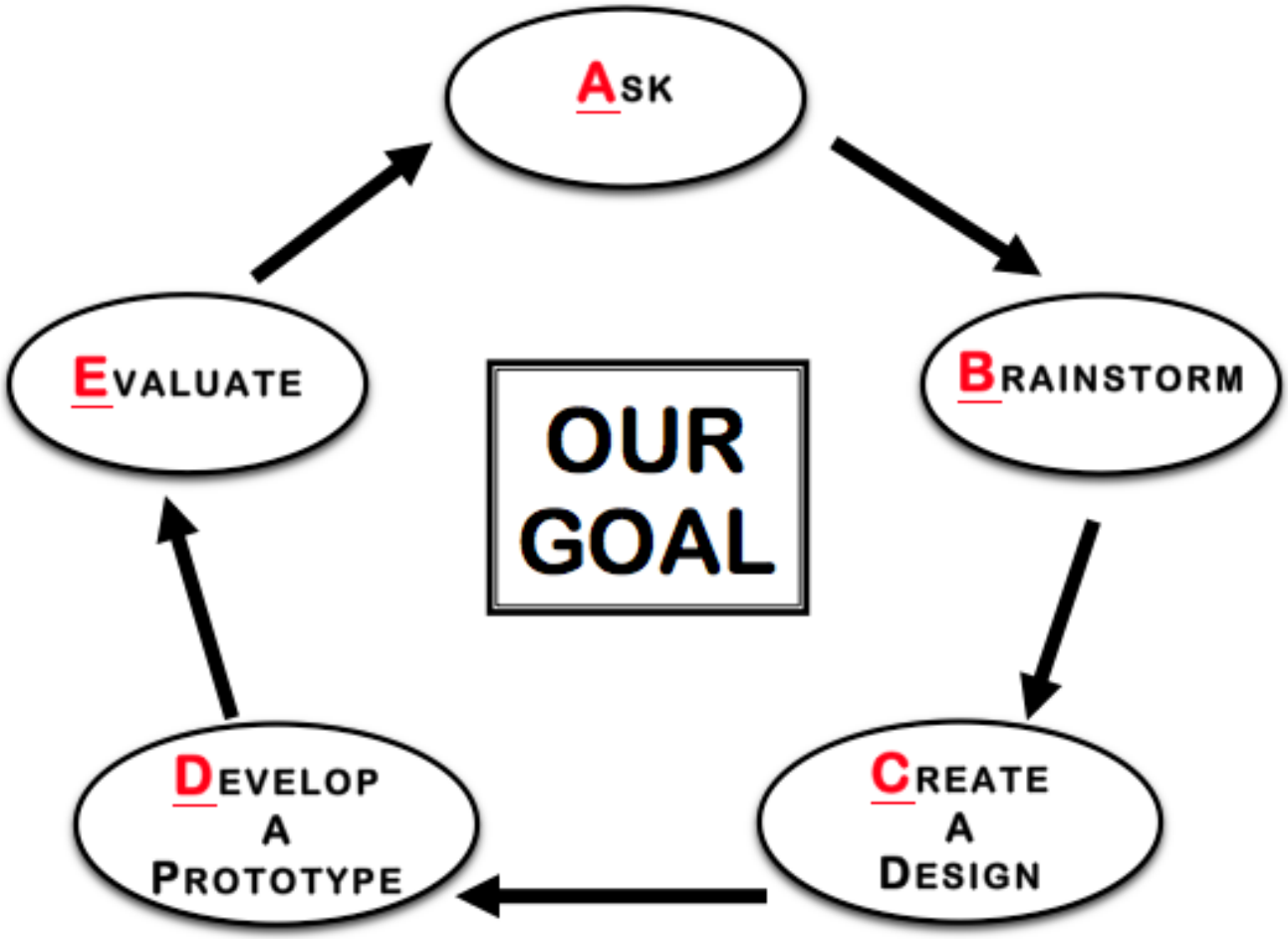
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.4.A.1** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
- **P1.4.A.3** Offering and supporting opinions and negotiating with others in communicative exchanges.
- **P1.4.B.5** Listening actively to spoken English in a range of social and academic contexts
- **P1.4.C.11** Supporting own opinions and evaluating others' opinions in speaking and writing

SPECIAL EDUCATION (SPED):

To make accommodations or modifications for students with special needs, provide simple directions, instructions, provide multiple opportunities for repetition, make frequent checks for understanding, use visuals to accompany all vocabulary, simplify questions, be specific with sequence and steps, provide opportunity for paraphrasing, and adjust time and pacing.

THE ENGINEERING DESIGN PROCESS (EDP)



ENGINEERING DESIGN PROCESS (EDP)

ASK

- What is the **problem** or **need**?
- What is already out there?
- What are the **requirements (criteria)** and **restrictions (constraints)**?

BRAINSTORM

- What are possible **solutions**?
- Choose your two best solutions.

CREATE - A - DESIGN

- **Draw** a diagram with labels.
- Have a critical design review (peer review & input).
- What materials are available?

DEVELOP - A - PROTOTYPE

- Follow your best diagram and **build** a prototype.
- **Test** the prototype!

EVALUATE

- **Improve** your prototype!
- Conduct more compatibility tests.

BACKGROUND FOR THE TEACHER

You may teach this lesson once students have completed:

FOSS CA – SOLID EARTH

- **Investigation 5, Parts 1 – 4**

After completing Investigation 5, Part 4, students will have gained the understanding that natural processes such as weathering and erosion can change the Earth, impacting human-made structures upon its surface.

MATERIALS

FOR EACH TEAM (4 students)

- 1 stream table tray
- 1- 1L cup of sand mixture (1L sand mixed with 1 9oz. cup of water OR reuse the same sand mixture from the erosion investigations) for plateau
- 1- 9oz. cup of sand mixture for "mountain"
- 1- tiny, toy house (Monopoly house/hotel works well)
- 1 tub (containing the following materials)
  - 1 15.25 x 15.25 cm pieces of aluminum foil
  - 1 15.25 x 15.25 cm plastic wrap
  - 1 coffee filter
  - 6 toothpicks
  - 6 craft sticks
  - 1 9oz. cup (for water)

FOR THE LESSON (materials for 8 teams of 4 students)

- Individual student engineering notebooks
- 1- 1L cup of sand mixture (plateau) for teacher demonstration
- 1- 9oz. cup of sand mixture (mountain) for teacher demonstration
- 1- tiny, toy house
- eye droppers (for rain)
- 50ml syringes (for wind)
- 1 pitcher of water to refill water

GETTING READY

1. **Schedule the Engineering Challenge**
   The erosion prevention challenge will take about two 60 minute sessions to complete.

2. **Gather / Obtain materials.**
   Prepare 1L cups of sand mixture, 9oz. cups of sand mixture, and tubs of materials.

3. **Plan Teams**

GUIDING THE ACTIVITY

Students will engage in the Engineering Design Process (EDP).

1. ASK

Setting the Context

- Discuss/review quick and slow changes to the Earth and show images/videos of erosion, making connections to local community catastrophes involving erosion: Big Sur - freeway damage & closures, La Conchita, mud slide onto homes, etc.

- Then, have students observe a model of the effects of wind and rain erosion on a "mountain", using a syringe to create the wind, and water drops from the eye dropper to represent rain. Ask students what they notice. They should see the erosion from the wind and rain causing a change in the shape of the mountain. Ask students how wind and rain erosion might affect the home on top of the mountain. *[Erosion of the mountain can endanger the home]* Discuss the variable of strength for wind and rain. How would greater rainfall or extreme winds change the rate of erosion?

- Have students write observations in their engineering notebooks.

Present Problem or Need

- Inform engineers of the CHALLENGE – *How can you effects of wind and rain erosion on a mountain community?*

- Have students record the Focus Question in their engineering notebooks - <u>How can you reduce the effects of wind and rain erosion on a mountain community?</u>

- Encourage students to come up with their OWN questions about materials, criteria, and constraints.
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Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed*:
  - Teams consist of four members
  - The "mountain" must be able to withstand a "wind and rain storm."
  - Student teams must agree upon on a way to standardize the wind and rain storm

- **Restrictions** (Constraints) *limitations that keep something from being the best it could be; may be problems that arise or issues that come up:*
  - Use only the materials supplied by teacher
  - The team design must incorporate an aspect of each team member's design
  - Use the agreed upon method to generate your wind and rain storm

2. BRAINSTORM

- Observe and evaluate available materials. Discuss and chart properties of materials and how the properties of materials help engineers pick the best material for the task/challenge.

- Have a whole class discussion, in general terms, about the kind of structure that might be needed in order to reduce wind and water erosion.

3. CREATE - A - DESIGN

- Each member must draw a design individually, without team member input, into his/her science notebook.
  - Title the page "My design"
  - Students should label parts of their design (i.e. mountain, wall, toothpick beam, etc.)

- Team members share designs with one another, compromise, and collaborate in order to create into a "team design."
  - Title the page "Team design"
  - Team members should label parts of their design
  - All Team members should have a voice

POSSIBLE BREAKPOINT

4. DEVELOP - A - PROTOTYPE

- Teams gather needed materials and build according to the team design.

- Test design
  - When a "wind and rain storm" moves over their team's mountain, how does their design protect the mountain from eroding?

  - How does their engineering design stand-up to multiple storms (x2 storms or x3 storms)

5. EVALUATE

- Have teams discuss their designs and results to the class. Focus on successes and failures. What worked? Why do they think it worked? How did the design fail? Did the entire design fail, or a portion of the design? How might they change their design to be more successful?

- After observation of other designs and input from colleagues, students redesign and rebuild.

- Have students answer the Focus Question in their notebooks.
  - For scaffolding, sentence frames work well. For example, "We reduced the effects of erosion from wind and rain by _____ ."

- Encourage students to include information about both their successes and failures.