LAUSD Elementary Engineering

DESIGNING HOMES FOR THE THREE LITTLE PIGS CHALLENGE

Second Grade - Earth Science

PURPOSE

IN THE <u>THREE LITTLE PIGS CHALLENGE</u>, STUDENTS WILL:

- Design and build a structure that solves the three little pigs' problem by 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>What scientific knowledge do you need to know about the properties of natural resources?</u>

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

2-PS1-1. **Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

2-PS1-2. **Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*** [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

2-PS1-3. **Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.** [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]

2-PS1-4. **Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.** [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

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.
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.(2-PS1-1)

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. (2-PS1-2)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.
- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3)

Engaging in Argument from Evidence
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
- Construct an argument with evidence to support a claim. (2-PS1-4)

- -

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Science searches for cause and effect relationships to explain natural events. (2-PS1-4)

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter
- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)
- Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)
- A great variety of objects can be built up from a small set of pieces. (2-PS1-3)

PS1.B: Chemical Reactions
- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)

Crosscutting Concepts

Patterns
- Patterns in the natural and human designed world can be observed. (2-PS1-1)

Cause and Effect
- Events have causes that generate observable patterns. (2-PS1-4)
- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)

Energy and Matter
- Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

- -

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science, on Society and the Natural World
- Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (2-PS1-2)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels:
4.ESS2.A (2-PS1-3); **5.PS1.A** (2-PS1-1),(2-PS1-2),(2-PS1-3); **5.PS1.B** (2-PS1-4); **5.LS2.A** (2-PS1-3)

Common Core State Standards Connections:

ELA/Literacy —

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. *(2-PS1-4)*
RI.2.3	Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-PS1-4)
RI.2.8	Describe how reasons support specific points the author makes in a text. *(2-PS1-2)*,(2-PS1-4)
W.2.1	Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., *because, and, also*) to connect opinion and reasons, and provide a concluding statement or section. (2-PS1-4)
W.2.7	Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1),(2-PS1-2),(2-PS1-3)
W.2.8	Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1),(2-PS1-2),(2-PS1-3)

Mathematics —

MP.2	Reason abstractly and quantitatively. *(2-PS1-2)*
MP.4	Model with mathematics. *(2-PS1-1),(2-PS1-2)*
MP.5	Use appropriate tools strategically. *(2-PS1-2)*
2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. *(2-PS1-1),(2-PS1-2)*

Students who demonstrate understanding can:

2-ESS2-1. **Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*** [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.]

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
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Compare multiple solutions to a problem.	**ESS2.A: Earth Materials and Systems** • Wind and water can change the shape of the land. **ETS1.C: Optimizing the Design Solution** • Because there is always more than one possible solution to a problem, it is useful to compare and test designs. *(secondary)*	**Stability and Change** • Things may change slowly or rapidly. - *Connections to Engineering,Technology, and Applications of Science* **Influence of Engineering, Technology, and Science on Society and the Natural World** • Developing and using technology has impacts on the natural world. - *Connections to Nature of Science* **Science Addresses Questions About the Natural and Material World** • Scientists study the natural and material world.

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-bands:
K.ETS1.A ; 4.ESS2.A ; 4.ETS1.A ; 4.ETS1.B ; 4.ETS1.C ; 5.ESS2.A

Common Core State Standards Connections:

ELA/Literacy —

RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. *(2-ESS2-1)*

RI.2.9 Compare and contrast the most important points presented by two texts on the same topic. (2-ESS2-1)

Mathematics —

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

MP.4 Model with mathematics. *(2-ESS2-1)*

MP.5 Use appropriate tools strategically. *(2-ESS2-1)*

2.MD.B.5 Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. *(2-ESS2-1)*

Students who demonstrate understanding can:

K-2-ETS1-1.	**Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**
K-2-ETS1-2.	**Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**
K-2-ETS1-3.	**Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

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 K–2 builds on prior experiences and progresses to simple descriptive questions.

- Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

Developing and Using Models
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.

- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

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-2-ETS1-3)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

ETS1.B: Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)

ETS1.C: Optimizing the Design Solution

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:
Kindergarten: K-PS2-2, K-ESS3-2
Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:
Kindergarten: K-ESS3-3, **First Grade:** 1-PS4-4, **Second Grade:** 2-LS2-2
Connections to K-2-ETS1.C: Optimizing the Design Solution include:
Second Grade: 2-ESS2-1

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

Common Core State Standards Connections:

ELA/Literacy —

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. (K-2-ETS1-1)
W.2.6	With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1),(K-2-ETS1-3)*
W.2.8	Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),*(K-2-ETS1-3)*
SL.2.5	Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(K-2-ETS1-1),(K-2-ETS1-3)*
MP.4	Model with mathematics. *(K-2-ETS1-1),(K-2-ETS1-3)*
MP.5	Use appropriate tools strategically. *(K-2-ETS1-1),(K-2-ETS1-3)*
2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1),(K-2-ETS1-3)

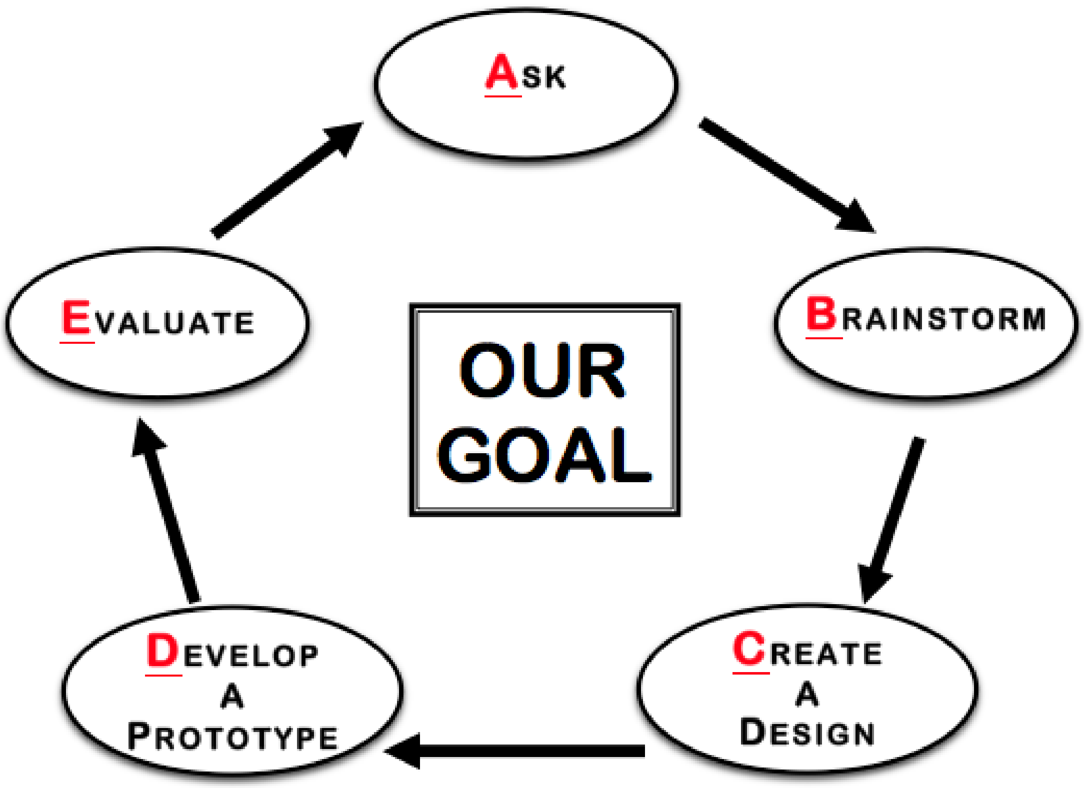
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.2.A.1:** Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics
- **P1.2.A.3**: Offering and supporting opinions and negotiating with others in communicative exchanges
- **P1.2.C.9:** Expressing information and ideas in formal oral presentations on academic topics
- **P1.2.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)



<u>ENGINEERING DESIGN PROCESS</u> (EDP)

ASK

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

BRAINSTORM

- What are possible **<u>solutions</u>**?
- Choose your two best solutions.

CREATE - A - DESIGN

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

DEVELOP - A - PROTOTYPE

- Follow your best diagram and **<u>build</u>** a prototype.
- **<u>Test</u>** the prototype!

EVALUATE

- **<u>Improve</u>** your prototype!
- Conduct more compatibility tests.

BACKGROUND FOR THE TEACHER

You may teach lesson once students have completed:

FOSS CA: Pebbles, Sand, and Silt

- **Investigation 2 (Parts 1-4)**
- **Investigation 3 (Parts 1-5)**

MATERIALS

Each team will use different building materials to allow for comparisons to be made.

FOR THE LESSON

- Individual Student Engineering Notebook
- Basins, 8-liter
- Clay, ceramic and dry powder
- Paper Plates
- Craft sticks
- Cardboard
- Straws
- Sand*
- Box of cornstarch
- Saucepan*
- Water
- Brick* (mini-loaf pans)
- Clay soil* (see Getting Ready for Making Bricks page 135)
- Dry grass and weed* (need to collect a few weeks before making bricks so the grass can dry)
- Foil*
- White glue
- Spoons
- Cups
- Towels*
- Small toy pig*
    - Hair Dyer or Fan* (to be used by the teacher)

* Supplied by teacher

**Teacher can add or take away from the materials list.

GETTING READY

1. **Schedule the Engineering Challenge**
   The challenge will take about three 45-60 minute sessions to complete:
   - Session 1: Setting the stage, Ask, Brainstorm, Create a Design, Develop a Prototype where students build bricks (let the bricks dry)
   - Session 2: Continue Create a Design (let the house dry)
   - Session 3: Evaluate

2. **Gather / obtain materials**

3. **Prepare Materials**
   - Pre-make sand matrix (directions found on **page 127** in FOSS Teacher Guide).
   - Dig up Clay Soil (directions found on **page 135** in FOSS Teacher Guide).

4. **Prepare materials by group or have stations**

5. **Plan Teams**
   - Plan for teams of 4 - 6.

6. **Print Focus Questions**
   Have Focus Questions printed on self-stick labels OR precut labels for gluing into Engineering Notebook –
   <u>What scientific knowledge do you need to know about the properties of natural resources?</u>

GUID`ING THE ACTIVITY

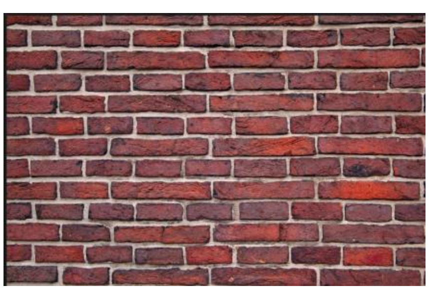
Students will engage in the Engineering Design Process (EDP).

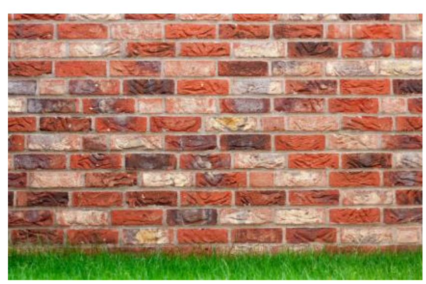
This lesson is based on the *Three Little Pigs* story. In this activity the students are to imagine that the wolf has already blown down the first and second pigs' houses and they must help the third little pig build a house so that when the wolf comes he cannot blow it down. Prior to this lesson, during a Read-A-Loud, read the story of The Three Pigs or tell the story of The Three Little Pigs.

1. ASK

Present problem or need

- Teacher says: "Students, the Big, Bad Wolf has just blown down two of the three little pigs' houses. The first and second pigs have run to the third pig's house. The pigs need your help! They need you to build a house that can fit all three of them and one that the Wolf cannot blow down. Save the pigs!
- What kind of houses did the first two pigs build? What happened to them when the wolf huffed and puffed?
- Together, research how bricklayer or masonry professionals lay bricks to build walls.
    - If you have a brick wall on campus, research that wall.
    - If you do OR don't research online.





Present Focus Question: What scientific knowledge do you need to know about the properties of natural resources? *(Printed on self-stick labels)*

- Display the Focus Question and have students stick/glue the Focus Question into their Engineering Notebooks.
  What scientific knowledge do you need to know about the properties of natural resources?

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed*:
  - Design a house that…
    - Fits 3 pigs
    - Will stay standing after Wolf blows on it.
    - Has an entrance
    - Can have windows (optional)
    - Fits on provided cardboard base
- **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 provided: (FOSS: Pebbles, Sand, and Silt)
    - Assign 1/3 of the class to clay bricks
    - Assign 1/3 of the class to sand bricks
    - Assign 1/3 of the class to dirt bricks
  - Time limits

2. BRAINSTORM

- What type of house and roof could an engineer design and build that the Wolf could not be able to blow down?

- How will we know if it will be able to stand up to Wolf's huffing and puffing?

3. CREATE - A - DESIGN

- Each member must draw a design individually (2-3 minutes), without team member input, into his/her engineering notebook.
  - Title the page "My design"
  - Students should label parts of their design

- Team members share designs with one another (3-5 minutes), compromise, and collaborate in order to create into a "team design" incorporating an aspect of each member's own design. (SEP-1)
  - Title the next page in the engineering notebook, "Team design"
  - Team members should each draw and label parts of this collaborative design
  - Team members decide about how many bricks they will need.
  - Team members decide what the roof will be made of and the design of the roof.

4. DEVELOP - A - PROTOTYPE

- Team make bricks (with materials assigned to their team)

  Note: The teacher may want to create a sample size for students or have a discussion on brick size that would work.

  The dirt bricks need foil separators to create smaller bricks and need about 6 – 7 days to dry. If possible, put out in the sun during the day.

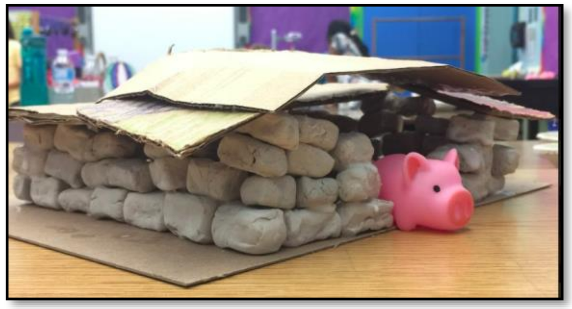
Sand Bricks

Clay Bricks

Dirt Bricks

--------- possible breakpoint -------------

- Teams use white glue as spackle to build the brick house
- Teams make a roof for the house
- Teacher can let each team have one pig as a reference point.



--------- possible breakpoint -------------

5. EVALUATE

- Test each design by seeing if three pigs can fit in the house.
- Test each design by using a hair dryer or a fan to simulate the huffing and puffing of the wolf. (10 seconds)
- If time allows, have the teams work on improving their designs.

EXTENSIONS (Optional)

- Design other structures that can be wind-tested
- Have students brainstorm constraints
- This site features an extension lesson plan. (www.teachengineering.org/activities/view/cub_earth_lesson1_activity1). The three little pigs may have survived the big, bad wolf but they are not prepared for the big, bad storm. The three little pigs need engineers to create a better brick for their house. The original brick house was damaged by the previous storm. Water had damaged the bricks.
- **Language Arts Activity:** There are many versions of *The Three Little Pigs.* Read two different versions and have the students find similarities and differences.
    - **Recommendations:**
    - Artell, Mike. The Three Little Cajun Pigs . New York: Dial Books, 2006. (The pigs build their houses in the swamp and Claude the Alligator is the villain)
    - Kellogg, Steven. The Three Little Pigs. New York: Morrow Junior Books, 1997 (modern day version with a happy ending)
    - Marshall, James. The Three Little Pigs. New York : Grosset & Dunlap, 2000 (Classic format of the tale with a few extras)