Three Little Pigs STEM Design Challenge and Standards Connections

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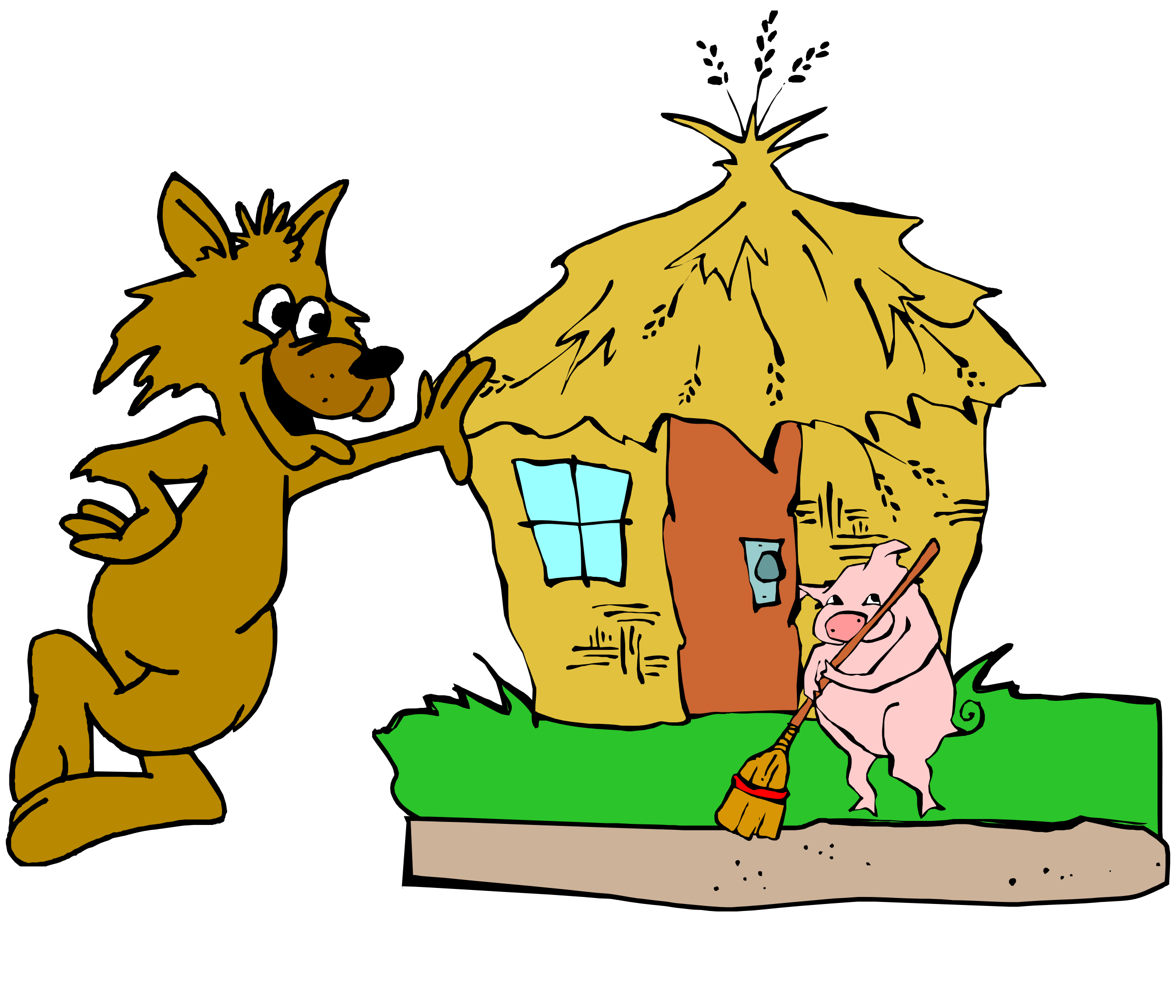

STEM Design Challenge Question: Can your team design and build a house that the big, bad wolf cannot blow down?

Overview: (Approximate instructional time 45-60 minutes; flexible)

This activity was designed for small teams to work on a design challenge using different materials. For the activity to function as designed, it requires a minimum of 6 people and can be scaled for larger groups. Participants will break into (at least) 3 teams and it is recommended there are at least 2 people per team. Each team will use different building materials (see below) to allow for comparisons to be made. There can be multiple sets of teams, but it is recommended there are equal numbers of each team. For instance, if there are 3 popsicle stick teams, then there would be 3 straw and 3 index card teams.

The design challenge is introduced by reading or recounting the story of the "Three Little Pigs." Participants are then challenged to build a house that the big, bad wolf cannot blow down (i.e., the box fan). The engineering design process is introduced and teams are given a set amount of time to build their houses. Then, testing of the houses in front of a box fan is done in front of the whole group and results are recorded to determine which materials and designs worked best. If time allows, teams may make modifications to their houses and test again. A self-reflection piece is recommended to capture student learning.

Materials: (described for a minimum of three teams)

- 1 copy of ***The Three Little Pigs*** by Paul Galdone for the whole group(any other version can be used, as well)
- Approximately 50 popsicle sticks for Team 1
- Approximately 50 small straws (e.g., for hot drinks) for Team 2
- Approximately 50 index cards for Team 3
- 1 thick, cardboard base (e.g., 5 ½ in.×8 in.) to serve as a foundation for each team
- 1 poster board roof (e.g., 4 in.×8 in.) for each team
- 1 yard of masking tape for each team
- 1 multi-speed box fan for the whole group (e.g., low, medium, and high fan speeds); if only a single speed is available, distance from the fan can be decreased to achieve low, medium, and high wind speeds.
- 1 Design Challenge Requirement Card for each team (see *Supplemental Materials*)
- 1 piece of paper and pencil for each team
- 1 Data Table for the whole group (see *Supplemental Materials*)
- 1 Reflection Page for each student (see *Supplemental Materials*)

Preparation and Adaptations:

- **Preparation:** In order to turn the box fan into the "Big, Bad Wolf," consider printing out and adhering the picture of the wolf to the top of the fan (see *Supplemental Materials* and *Artifacts* documents). Then, "low" fan speed can be referred to as "Huffing and Puffing Level 1," and so forth.
- **Preparation:** Set up a "Materials Science Table" for teams to pick up what they need for the challenge. When deciding on supplies to serve as "straw, sticks, and brick," consider possible recycled or reuse items (see *Artifacts* document). The materials described in this lesson are easily found in formal or informal educational settings, or available for purchase at low cost. If you are working with more than three groups, variations on building materials can also be tried (see below for "*Materials Science Adaptation*"). It is recommended that foundations and roofs are made of the same materials for all groups for a more accurate comparison of the effects of different building materials (e.g., straw, sticks, and brick).
- **Engineering Adaptation:** In this example, each team is provided a standard roof and foundation. The target age for this lesson is Pre-K-4th grade. If you have more time or upper level students, or simply desire a more challenging approach in your setting, the task of engineering the roof and foundation could be added to the design challenge, within certain constraints (e.g., specific sizes or specific materials as described in the "*Materials*" section). The adaptation is at the discretion of your setting, time constraints, and audience.
- **Math Connection/Adaptation:** To increase the understanding of how math can be reinforced, students can inventory the supplies used in the house and a cost sheet could be supplied by the instructor (e.g., cost could vary in complexity for the different ages of students). Students can evaluate the final cost of their home and share that as part of presenting their design for testing. Regardless of design success when tested in front of the box fan, the instructor could challenge students to figure out the cost of improvement to meet success, or to minimize total cost.
- **Materials Science Adaptation:** Different sized "straws" (e.g., coffee, soda, or wide-mouth, etc.), "sticks" (e.g., popsicle sticks of different lengths and widths, wooden stirring sticks, real sticks, etc.), and "bricks" (e.g., cardboard from cereal boxes, cleaned and cut-out juice carton walls, glued vs. unglued index cards, etc.) can be used to test the effects that building materials, from the same category, can have on design performance. Styrofoam bases (e.g., cleaned food packaging materials) could serve as the foundation for the houses instead of cardboard, or corrugated cup holders instead of poster board could serve as roofs. Different costs can be associated with different materials of the same category, as well. See *Artifacts* document for examples.

- **Multi-cultural Adaptation:** Many versions of ***The Three Little Pigs*** exist in (school) libraries, including ones that reflect the same story through a different cultural lens (e.g., ***The Three Little Javelinas***, a southwestern adaptation, by Susan Lowell, illustrated by Jim Harris). Consider your audience when choosing the version you wish to share, or just have multiple versions on display for participants to explore.
- **Standards Adaptation:** At the end of the design challenge, if time allows, have each team give an oral presentation of what they would do to optimize their house design. This adaptation supports the Common Core State Standards (CCSS) of "Speaking and Listening," as well as NGSS Science and Engineering Standard of "Obtaining, evaluating, and communicating information."

Procedure:

1. Read aloud "***The Three Little Pigs***" to the class
   - Consider using the GLAD Narrative input chart (**Project GLAD**: Guided Language Acquisition Design) as a strategy to support early reader and language diverse students.
   - More information on GLAD strategies can be found at http://begladtraining.com
2. After reading, discuss the need to build a good strong house. Consider linking it to local weather conditions (e.g., wind, tornadoes, and hurricanes; see *Artifacts* document for an example).
3. Divide students or participants into at least three teams of two.
4. Introduce the "*Three Little Pig STEM Design Challenge Requirements Card*" (see *Supplemental Materials*).
5. Introduce students to the "*Engineering Design Process*" (see *Supplemental Materials and Artifacts* documents).
6. Show students the "Big, Bad Wolf" fan so they understand the force of the wind (i.e., huffing and puffing level) they will be trying to build the house to withstand.
7. Assign each team a material to work with (e.g., straw, sticks, or brick).
8. Encourage students to draw or sketch a design idea first.
   - Note: This step supports the NGSS (Next Generation Science Standard) Science and Engineering Practices of "Planning and carrying out Investigations" and "Developing and using models," for example.

9. Hand out or have one person from each team gather the appropriate building materials from the Materials Science Table. Pass out one yard of masking tape to each team.
   - Each group is only assigned or given one material to work with.
10. Establish a time limit for designing, redesigning, and building and allow teams to start building (e.g., 20 minutes).
11. When time is up, have each team bring their house to the testing zone where they can share their design with other groups.
12. Have the students place/orient their house in the test zone as they wish it to be tested.
    - Note: The same distance from the fan should be used for all groups.
13. Turn the fan on low (i.e., Huffing and Puffing Level 1") for 10 seconds. If it survives, go to medium (i.e., "Huffing and Puffing Level 2") for 20 sec. If it survives, turn the fan high (i.e., "Huffing and Puffing Level 3") for 30 sec. If the house is still standing…. SUCCESS! If not, it is a good opportunity for teams to think of design improvements after seeing other houses.
14. Use the group Data Table (see *Supplemental Materials*) to record each team's results for analysis.
    - Note: This step the NGSS-Science and Engineering Practices of "Analyzing and Interpreting Data," for example, in the "Standards Connection" section (this document).
15. Test all houses.
16. Discuss results as a group (see "Conclusions" section below).
17. Have each team discuss and document what they would do to improve their design.
    - If time allows, allow for modifications (i.e., re-design) and re-testing.
18. Hand out one "Student Reflection Page" to each student (see *Supplemental Materials*). Allow students reflection time to evaluate their work and design.
    - If time allows, consider "Standards Adaptation" (previous section).

Conclusion: Group discussion or written responses as time and age level allows.

- Based on the "Data Table," what materials appear to withstand the huffing and puffing of the "Big, Bad Wolf" the best?
- Why do you think these materials were more effective than others?

- Was your team able to design and build a house that survived the "Big, Bad, Wolf?"
- What "Huffing and Puffing" level did your house withstand?
- Even if your house survived, what would you do to improve your design based on other houses that you observed?
- Thinking about the real world, can you come up with a list of all the different jobs or people need to build just one house?
- How many of these jobs require an understanding of science, technology, engineering, and/or math? (star or highlight them on the list)

Example of the "Design Challenge Requirement Card" (available for printing in "*Supplemental Materials*"):

STEM Design Challenge: **Can your team design and build a house that the big, bad wolf cannot blow down?**

Design Requirements:

1. **Your house must be built on the foundation provided and use the roof provided.** (Note: The roof is the top of the house and the foundation what the house is built on.)
2. **Your house must be built with only the materials you are provided.**
3. **Your team must have "fair-share work"- listen to all ideas!**
4. **Your team only has 20 minutes to complete this task and be ready for testing.**

Standards Met in Common Core State Standards (CCSS) & Next Generation Science Standards (NGSS):

CCSS- Reading Literature

Kindergarten Key Ideas and Details:

CCSS.ELA-Literacy.RL.K.1
With prompting and support, ask and answer questions about key details in a text.

CCSS.ELA-Literacy.RL.K.2
With prompting and support, retell familiar stories, including key details.

CCSS.ELA-Literacy.RL.K.3
With prompting and support, identify characters, settings, and major events in a story.

First Grade Key Ideas and Details:

CCSS.ELA-Literacy.RL.1.1
Ask and answer questions about key details in a text.

CCSS.ELA-Literacy.RL.1.2
Retell stories, including key details, and demonstrate understanding of their central message or lesson.

CCSS.ELA-Literacy.RL.1.3
Describe characters, settings, and major events in a story, using key details.

Second Grade Key Ideas and Details:

CCSS.ELA-Literacy.RL.2.1
Ask and answer such questions as *who, what, where, when, why*, and *how* to demonstrate understanding of key details in a text.

CCSS.ELA-Literacy.RL.2.2
Recount stories, including fables and folktales from diverse cultures, and determine their centra message, lesson, or moral.

CCSS.ELA-Literacy.RL.2.3
Describe how characters in a story respond to major events and challenges.

Third Grade Key Ideas and Details:

CCSS.ELA-Literacy.RL.3.1
Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

CCSS.ELA-Literacy.RL.3.2
Recount stories, including fables, folktales, and myths from diverse cultures; determine the central message, lesson, or moral and explain how it is conveyed through key details in the text.

CCSS.ELA-Literacy.RL.3.3
Describe characters in a story (e.g., their traits, motivations, or feelings) and

explain how their actions contribute to the sequence of events

Fourth Grade Key Ideas and Details:
CCSS.ELA-Literacy.RL.4.1
Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
CCSS.ELA-Literacy.RL.4.2
Determine a theme of a story, drama, or poem from details in the text; summarize the text.
CCSS.ELA-Literacy.RL.4.3
Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions).

Fifth Grade Key Ideas and Details:
CCSS.ELA-Literacy.RL.5.1
Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
CCSS.ELA-Literacy.RL.5.2
Determine a theme of a story, drama, or poem from details in the text, including how characters in a story or drama respond to challenges or how the speaker in a poem reflects upon a topic; summarize the text.

CCSS- Speaking and Listening K-5

K-5 Comprehension and Collaboration:
CCSS.ELA-Literacy.SL.1
Participate in collaborative conversations with diverse partners about *kindergarten topics and texts* with peers and adults in small and larger groups.
CCSS.ELA-Literacy.SL.1.a
Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
CCSS.ELA-Literacy.SL..1.b
Continue a conversation through multiple exchanges.

NGSS-Performance Expectation Examples

Physical Science and Engineering Design

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

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.
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
3-PS2-1	Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
3-PS2-2	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
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.
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.

NGSS-Science and Engineering Practices
The eight practices of science and engineering that are identified as essential for all students to learn and describes in detail are listed below: 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
NGSS-Crosscutting concepts
The purpose of Cross Cutting Concepts is to help students deepen their understanding of the disciplinary core ideas and develop a coherent and scientifically based view of the world. The seven crosscutting concepts this lesson supports are as follows: 1. ***Cause and effect****: Mechanism and explanation*. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts. 2. ***Scale, proportion, and quantity****.* In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. 3. ***Systems and system models.*** Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
NGSS- Disciplinary Core Ideas (DCI)
The DCI focus is on the grade band end points for a more formal classroom setting. Please refer to the NGSS documents for a closer alignment to the specific science concept suited to your needs. As an example this lesson aligns well for NGSS – DCI for kindergarten.