The “big bad wolf” chased the squealing children around the playground as they looked for a place to hide. Because Mr. López and Ms. Kim had introduced the work of engineers and the engineering design process into their unit on The Three Little Pigs, they knew their preschool students would choose a structure that could withstand any huffing and puffing from the wolf. They also knew that their students could do the work of engineers because it aligns with children’s desire to help people or, in this case, three little pigs, and it taps into their natural curiosity and problem-solving abilities.

Day 1: Meeting the Three Little Pigs

Mr. López began the unit by reading The Three Little Pigs (Jewitt 2012). Afterward, he told students that they would be designing and building a new home for the pigs. The engineering design process begins with asking questions. Mr. López started by asking students to think about what the pigs might need. Students decided the pigs needed three bedrooms, a living room with a big screen TV, a big kitchen because pigs like to eat, and a playroom with a trampoline because pigs like to jump. These became the constraints or “must haves” for their house design.

Engineers learn about problems from failures (Petroski 2018). So, to help the students identify the problem to solve, Mr. López asked, “Why did the first and second pigs’ homes fall down but not the third pig’s home?” Students knew that straw and sticks are easy to break but bricks are strong. He then asked “Why would someone build a home with straw or sticks instead of bricks?” They realized that straw and sticks are easy to find, while bricks take time to make. Mr. López summarized the problem: a house built too quickly out of weak materials might fall down. He then asked how they might solve that problem when building their houses. Students said that they would take their time and build with strong materials. Agreeing, Mr. López told students that they were thinking like engineers. To solve the problem, they would follow the engineering design process. The students would research possible materials they could use to build their house, imagine the structure they wanted by drawing a plan or blueprint, create a model house and test it, and then create their house to share at an open house.

On day 1, by Asking Questions and Defining Problems, the students developed constraints for the house the rooms needed and identified a problem to be solved: the strength of building materials. In coming days, they would be Developing and Using Models by creating plans and making prototypes or models from different materials for testing, and Analyzing and Interpreting Data from their tests to see what works and finalize their house design.

Day 2: Researching and Planning

To research the problem of building materials, Mr. López began by reading The Three Pigs: An Architectural Tale (Volume 57, Issue 3) by Barbara A. Bradley, Kelli Thomas, and A. Allen Bradley Jr.
After the story, the class discussed why some houses fell down in this story and why some had not. In small groups, students gathered around boxes with potential building materials (see Figure 1 for a list of materials needed for all activities). Exploring samples of building materials helped students consider what made some materials better for constructing a house than others. For example, they decided that rocks and plastics would be the best materials to build a house because they are hard, while the cotton balls and fabric would make good beds because they are soft. After listing what materials did and did not work on a chart, the class talked about what materials they might use to build their house for the little pigs. While bricks were a popular idea, students decided that other materials, such as cardboard boxes, would be easier to get. They completed the chart by adding the materials they could use to build their house.

FIGURE 1

It was now time to imagine their dream house for the little pigs and draw it out on paper. The houses needed space for the bedrooms, living room, kitchen, and playroom, but could be any size or shape. Many students sketched traditional houses with one or two stories. Some drew tall houses like a high-rise with multiple stories. See Figure 2 for an example a student drawing. Mr. Lòpez told the class that just like engineers, they had imagined many possible designs that solved the problem. Tomorrow, they would explore some alternatives in more detail.

FIGURE 2

Days 3–4: Creating a Prototype and Testing

Students were eager to build their houses. But Mr. Lòpez told them that he had talked with his sister, a civil engineer, about the houses they would be building. She explained to him that houses are not built the same way everywhere in the world. In some places the ground is hard and in others it is soft. In some places, the ground shakes from earthquakes. In some places snow will pile up winter. In others there will be torrential rains. Mr. Lòpez reminded the students that they had solved the problem of the huffing-and-puffing of the wolf by choosing strong materials. But bad weather can cause even more damaging wind. Mr. Lòpez explained that with the help of his sister, he devised ways to test whether their imagined houses could handle these problems, too. Since students had imagined houses of different shapes from short to tall, today they would test how each worked on soft and hard ground. Half the class went with Mr. Lòpez to test house shapes on soft ground; half the class went with Ms. Kim, the assistant teacher, to test house shapes on hard ground.

Mr. Lòpez asked his group to first build a prototype or model house with drinking straws. Some students built model houses one straw high, and other students taped together additional straws to make to the houses two and three straws high. Mr. Lòpez then showed students the ground for their houses, a mound of gelatin made at home the previous day. He asked them to predict if their house would remain standing or fall down. Then, the students carefully placed their straw houses into the gelatin. All the houses remained standing! However, the students realized that the tallest houses that were three straws high were bent over; they had not fallen down, but they were not as straight and stable as short houses that were one straw high. Mr. Lòpez then asked students to predict what might happen if he wiggled the plate back and forth to simulate an earthquake. As he gently wiggled the plate of gelatin, the tallest structure began to sway and fall over. The students were curious and wondered if more tape might help the structures. After discussing what happened and why, they concluded gelatin was too soft to build tall houses. However, they learned that shorter houses worked better on softer ground, especially when the ground shook. Introducing the Building a House chart to record their findings (Table 1, p. 43), students indicated that “no” they shouldn’t build a house on soft ground like gelatin because it’s “too wiggly” and students suggested they “find hard dirt ground.”
### Building a Strong House

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How can I fix it?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Can we build a house on...</strong></td>
<td></td>
</tr>
<tr>
<td>Gelatin</td>
<td></td>
</tr>
</tbody>
</table>

“No, too wiggly. Find hard dirt ground.”

Ground prone to earthquakes

“Yes, build a house with a big or wide base.”

### Can our house withstand strong forces?

| Hurricane: strong wind and rain |  |
| “Lego houses work but paper cup houses blow away.” |  |
| Blizzard: a lot of snow is heavy |  |

“Lego houses work but paper cup houses fall down.”

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Ms. Kim asked her group to build a model house with small paper cups on hard ground: a solid table. She put a sheet of paper on the table and asked the students to first build a tall house on top of it. To simulate an earthquake, students moved their paper back and forth. The paper cup houses toppled and, as expected, chaos followed. After several trials and errors, students were building paper cup houses with a wide base like a pyramid, rather than a tower, to withstand gentle shaking but never vigorous shaking! They discussed their findings and recorded them on the chart.

Afterward, the two groups shared their findings by reviewing the Building a Strong House chart. Students in Mr. López’s group said that when the ground is too soft, a tall house might tip over. Shorter houses are more stable on soft ground, especially in an earthquake. Students in Ms. Kim’s group were excited to share that they also learned it was better to build a shorter house in an earthquake prone area, even on hard ground. Students then acted out these ideas. Some students stood on their tippy-toes to represent tall structures and other students crouched on their hands and knees. When Mr. López shouted “earthquake!” the tall structures swayed back and forth and crashed to the ground. The short structures wiggled but did not fall down. After switching roles, Mr. López said, “soft ground” and tall structures began to wobble. When he shouted “earthquake!” they all fell down. Students made it clear that they would be building a short house for their pigs. For additional activities, see [Internet Resources](#) for videos, songs, and interactive games.

On day 4, Mr. López reminded the students that his civil engineer sister said they should consider the types of weather that can damage a house. Students eagerly shared ideas about bad weather such as “piles of snow” and “wind that breaks a kite.” Mr. López explained that hurricanes are big storms with lots of rain and wind, and that blizzards are big storms with lots of snow and wind. He then explained that they would be conducting investigations...
to see if their houses could withstand hurricanes and blizzards. Dividing students into two groups, one group built houses by stacking and taping small paper cups together, while another group built small houses with Legos. Then, putting students in pairs, one with a paper cup house and one with a Lego house, Mr. López asked several pairs to go with Ms. Kim while others would work with him.

Students working with Ms. Kim determined if their houses could withstand strong winds. Students made predictions about their own house and Ms. Kim recorded the information. Ms. Kim explained that they would simulate wind with a hair dryer (a fan would also work). With the teacher armed with the hair dryer set on cold, the hurricane began! As students correctly predicted, the paper cup house blew away; however, the Lego house didn’t “break into pieces.”

Meanwhile, Mr. López’s students were busy making snow with a sno-cone machine and filling sandwich-size plastic bags to simulate heavy, wet snow that piles onto the roof of a house during a blizzard. As an alternative to using a sno-cone, a teacher could crush ice in a blender or buy crushed ice at a store prior to the activity. After several bags of snow had been made, students predicted what would happen and Mr. López recorded the information. With great trepidation, each child placed one, two, or three bags of snow on top of his or her house. The load was too great for the paper cup house and the roof caved in (see Figure 3), but the Lego houses stood strong.

**Days 5–8: Creating and Testing Houses**

Students were excited to share their findings with their peers. They learned that they needed to build short houses, preferably on hard ground so they wouldn’t topple over. They also needed to use strong, heavy materials to withstand heavy wind and blizzards. Mr. López then read the first half of *Look at That Building! A First Book of Structures* (Ritchie 2011) to reinforce important ideas such as drawing a blueprint, building on a strong foundation, and choosing materials wisely to construct frames and walls (see Resources for books about construction). Students revised their blueprint and chose sturdy items from recycled materials to construct their houses.

Day 6, Mr. López read *How a House Is Built* (Gibbons 1990) and day 7, he read *Iggy Peck Architect* (Beaty 2007). After discussing each book, students followed their blueprints as best they could to build their houses with the recycled materials. In addition to building houses, a few students decided to create other buildings for the pigs. For example, one student created a recording studio. Another student built a grocery store. When their structure was complete, each student tested his/her house with a teacher to determine if it could withstand an earthquake, strong winds, or a blizzard. While most houses withstood the forces, when a design failed, it created an opportunity for the student and teacher to reflect on the design and determine how to fix it. For example, the student who built a recording studio for the pigs found that the structure moved in strong winds. He decided to put rocks in his structure to make it heavier. After retesting his improved design, he learned the rocks worked and they became “chairs” for the pigs. Based on the outcome of the tests, some students improved their houses, most often by reinforcing their structures with additional and/or stronger materials e.g., cardboard or tape and glue. As students tested their houses, Mr. López and Ms. Kim used a summative assessment and rubric to evaluate individual student learning related to key aspects of the process (see NSTA Connection). They asked questions that focused on the original problem (e.g., two pigs built quickly and with poor materials) and how weather conditions influenced their prototypes and the houses they created from recycled materials. On day 8, students painted and decorated their house. They also made little pigs by painting materials such as rocks and toilet paper tubes cut in half, and gluing on googly eyes, button noses, and pieces of pipe cleaner for tails (Figure 4, p. 45).

**Day 9—10: Hosting an Open House**

Students learned about the engineering design process as they thought about the structural failures experienced by the first two pigs and success of the third pig. Based on their suggestions, students reviewed what they had learned from their investigations so they could share that information with visitors coming to an open house (Table 2). The
students practiced what they would tell visitors about their investigations and homes before the open house.

<table>
<thead>
<tr>
<th>REVIEWING THE ENGINEERING DESIGN PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINEERING DESIGN PROCESS</td>
</tr>
</tbody>
</table>

WHAT WE LEARNED

ASK: What do the pigs need and must have (constraints)?

- Little pigs need a strong house so a wolf can’t blow it down and eat them
- Pigs need a big house with lots of rooms
- We can fix problems

RESEARCH: What are some problems?

- Building too fast is a bad idea
- Building with straw and sticks is a bad idea
- We need to build slowly
- We need to build with strong, hard materials

IMAGINE: Develop possible solutions

- Houses can be really big or really small
- Houses can be all different colors

PLAN: Select a promising solution

- We can draw a picture for a house we want to make for the pigs

CREATE: Building a prototype (house).

- We can make a house of paper cups and Lego blocks to think about buildings

TEST: Evaluate the prototype (house). Does it work?

- Don’t make a paper cup house
- A paper cup house blows away in strong air (wind)
- It’s fun to make snow
- We made snow with a snow machine and put snow on the roof
- Snow is heavy and breaks a roof

IMPROVE: Redesign as needed

- We used recycled things to make a house
- We use lots of glue and tape
- We can use recycled stuff to save Earth and trees
- I put rocks in the house to make it heavy
- Don’t make a house really tall

The Open House was a success as parents, the principal, staff, and other classes came to see homes. Students told them about their investigations and answered questions. Visitors appreciated what students had learned and the home they built, and wrote kind notes on the students’ final checklist.

Conclusion
Students enjoyed helping the three little pigs as they asked questions; identified problems; imagined solutions; planned, created and tested model houses; and built, tested and improved their design to build strong, safe houses (Pantoya, Aguire-Muñoz, and Hunt 2015). *The Three Little Pigs* effectively introduced young students to the engineering design process, and like engineers, they helped solve a problem.

**Connecting to the Next Generation Science Standards (NGSS Lead States 2013)**

**Standard**

K-2-ETS1 Engineering Design

[www.nextgenscience.org/dci-arrangement/k-2-ets1-engineering-design](http://www.nextgenscience.org/dci-arrangement/k-2-ets1-engineering-design)

- The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.
- The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectation listed below.

**Performance Expectation**

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.

**References**
This Three Little Pigs STEM Challenge is a brilliant science experiment for learning about stability of structures and properties of materials. It’s great for Early Years Science age, but can also be extended for older children too. If you like this, you might also like our Gingerbread Man science experiments. We made six different types of Three Little Pig houses loosely based on the story, Three Little Pigs STEM Challenge. What you need. Sticks. Smaller, harder sweets and cocktail sticks might work better. Three Little Pigs STEM Challenge Extension Tasks. Try spraying each house with water and observing what happens. Can you make predictions first? The Three Little Pigs storytelling Lesson Plan with percussion instrument sound effects and improvisation - it’s so much fun! 1. First spend a little time teaching the song which is super quick to pick up with it’s repetitive words and familiar tune. Do this by singing it to them first, then taking two lines at a time, and encourage the children to join in after they have heard it a couple of times. The tune is borrowed from ‘Little Brown Jug’ and there is a chime bar clip to listen to below if you’re not familiar with it.