THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Blow the House Down

Build a house that won't blow away.

GRADE K

Engineering Design

VAN ANDEL EDUCATION INSTITUTE

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INQUIRY-BASED SCIENCE

Engineering Design

Blow the House Down

Grade Level/Content	K/Engineering Design
Lesson Summary	Inspired by the *Three Little Pigs*, students construct their own houses that can withstand the big bad wolf's huffing and puffing. They put their houses to the test and vote on the most successful design.
Estimated Time	2, 45-minute class periods
Materials	Photos of hurricanes or tornadoes and the damage they cause; variety of objects that can be used to build a representation of a house (straws, toothpicks, blocks, sticks, rocks, Styrofoam pieces, paper plate strips, cardboard, etc.); small object to represent a person; Engineering Form; Journal
Secondary Resources	• *The Three Little Pigs* (any print version of the story) or a video such as this Three Little Pigs (3:18 minutes) • *The Greedy Triangle*, by Marilyn Burns • *Shapes That Roll*, by Karen Nagel • *How a House Is Built*, by Gail Gibbons • *Rosie Revere, Engineer*, by Andrea Beaty • *I Face the Wind*, by Vicki Cobb • *The Wind Blew*, by Pat Hutchins
NGSS Connection	**K-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-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.
Learning Objectives	• Students design and build a house that can withstand wind. • Students communicate the connections between the shape(s) of their house and how it withstands the wind. • Students evaluate the performance of houses and use data to describe the strengths and weaknesses of each design.
Cross-Curricular Project Connections	There's No Place Like Home; Wonders of Wind

Build a house that won't blow away

Everyone loves a good story, so why not use one to kick off an engineering design challenge? In this lesson, students read or watch a video of *The Three Little Pigs,* and then design solutions for a house that cannot be blown away. Engineering lessons help students develop creative problem-solving skills as well as adaptability and perseverance. They also provide an opportunity for children to work together and collaborate. Enjoy watching students find creative solutions that they are proud to share!

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Engineering Design. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Students will need

- Photos of hurricanes or tornadoes and the damage they cause
- 5–6 sets of objects that can be used to build a representation of a house (straws, toothpicks, blocks, sticks, rocks, Styrofoam pieces, paper plate strips, cardboard, etc.). Make sure to have light, medium, and heavy objects.
- Small object to represent a person
- Engineering Form
- Journal

Part 2

INVESTIGATION FACILITATION

Secondary Knowledge

Engage students with a familiar story and introduce how wind can negatively affect houses.

- Read or watch your favorite version of the fairy tale, *The Three Little Pigs*.
- Discuss the story, focusing on the effect the wolf's blowing (wind) had on each of the houses.
- Explain that although we may not have to worry about big, bad wolves blowing our houses down, we do have to worry about wind. Explain that engineers are always looking for ways to build stronger houses that are less likely to be damaged by wind.

STUDENT ENGAGEMENT

Students are always more engaged when they see how what they are learning is used outside of school. Show images of hurricanes and/or tornadoes and the damage they can cause to houses so students see the importance of engineering solutions that protect houses from wind damage.

Problem

Introduce the problem statement.

Problem Statement: Build a house that won't blow away.

Challenge students to build a house that won't blow away.

The house needs to...

- ☐ be big enough to cover one person (using a small object to represent a person).
- ☐ have a roof and walls.
- ☐ stay undamaged after blowing at it from 4 different sides.

Students must...

- ☐ only use the materials that are provided.
- ☐ continue building, testing, and improving designs for the entire time given, even if they have found a solution.

Personal Knowledge

Students capture what they already know about building a strong house.

Ask students to think about what makes a house strong. Have them write or draw what they know about strong houses in their journal. Then, have them discuss what they know with a partner.

CRITICAL THINKING

Students love discussing how their brains actually work, so conduct a *Call Out the Brain* to encourage critical thinking. Our brains find it easier to learn something new if we link it to something we already know. The specific part of the brain used in this process is the medial prefrontal cortex. Encourage students to always think about what they already know about a topic before they try to learn something new about it.

Possible Solutions

Students brainstorm design solution(s) to solve the problem within the criteria and constraints.

- Divide students into groups of 4 or 5.
- Give each group a set of objects that students can use (some light, some medium, some heavy).
- Give teams the Engineering Design Form.
- Have students look at the materials and brainstorm ideas for how they might design a house that won't be blown away. Encourage them to discuss and draw a variety of possible solutions.
- Have them draw their possible solution on the form.
- Students should then select one of their design ideas to test.

CREATIVITY AND CRITICAL THINKING

- Encourage students to "mess about" with the materials provided. Have them make observations to help them think creatively as they brainstorm. From that list, students will need to be critical thinkers as they select the ideas for their design solution.

Solution Test

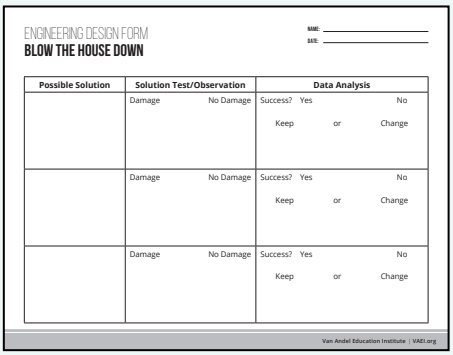
Students build and test a possible solution.

- Have students build and test their possible solution by blowing on their house from the front, back, and each side.
- After trying to blow the house down, students should record their results.

Observation

Students document their observations.

- Have students record their observations on the **Engineering Design Form.**
- Students should record if there was any damage (circle "Damage" or "No Damage") and draw what happened in the "Solution Test/Observation" section.
- Students may be tempted to begin refining or developing a new possible solution once they test their house. Encourage them to continue through the observation and data analysis process to provide evidence that informs their new design.


ENGINEERING DESIGN FORM
BLOW THE HOUSE DOWN

NAME: _____
DATE: _____

Possible Solution	Solution Test/Observation	Data Analysis
	Damage No Damage	Success? Yes No Keep or Change
	Damage No Damage	Success? Yes No Keep or Change
	Damage No Damage	Success? Yes No Keep or Change

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Engineering Design Form

ADAPTABILITY

Teach students to value the exploration of multiple plans and possible solutions to a problem. Sometimes students get stuck on plan A and are unable to move quickly to the exploration of plan B.

INTEGRITY

Encourage students to record their observations accurately. Sometimes students want a solution to work so badly that they see what they want to see. Ask probing questions: *Are you sure…? How do you know…?* Also, make sure students understand that you value discovering what really works best over getting it "right" on the first, second, or third try.

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

Students make sense of their data and use it to inform additional solutions.

- Have students analyze their data using the established criteria for success:
  - It needs to be big enough to cover one person (using a small object to represent a person).
  - It needs to have a roof and walls.
  - It needs to stay undamaged after blowing at it from 4 different sides.
- On the **Engineering Design Form**, have students circle "Yes" or "No" to indicate if the success criteria were met.
- Have students interpret their results by indicating if they want to "Keep" or "Change" this design. They can circle their choice on the form. If they choose "Change", they can draw or write what change they want to make.
- Challenge students to design another possible solution and repeat the process (Possible Solution, Solution Test, Observation, and Data Analysis) during the allotted time on the **Engineering Design Form**. You may have students take pictures of their subsequent designs as they refine and/or create new possible solutions. Even if the students find a solution, have them continue designing, building, and testing improved solutions for the entire time they are given.

Continued

PERSEVERANCE

Students sometimes need help knowing what to say to themselves to stay motivated. Saying things such as, "This is too hard!" or "I don't know how to do this!" become barriers to developing perseverance. Teaching kids alternative language, such as, "I know I can do this!" or "If I get stuck I can ask a friend or the teacher for help!" supports the development of perseverance.

Secondary Knowledge

Students use secondary sources to understand how shapes relate to the strength of a house.

- Use these resources (or your own) to help students understand how some shapes are better for houses than others.
  - *The Greedy Triangle*, by Marilyn Burns
  - *Shapes That Roll*, by Karen Nagel
- Discuss the physical qualities of the house designs. Explain how the shape, weight, and thickness of the materials affect the strength of the house.
- Discuss the strengths and weaknesses of the "Keep" designs. As a class, use evidence to choose the house design that is best able to withstand the wind.

CONSTRUCTION OF MEANING

Encourage students to make connections between the shapes they discussed in the books and their own design solutions. Have them share with a partner any connections *(This wall is a square, this roof is a triangle, etc.).* Connecting what they read to what they have done solidifies understanding and builds confidence.

Explanation

Students develop a claim and provide evidence and reasoning to support it.

- Create a class explanation as a *Shared Writing* activity. Use what students discovered from the analyzed data to develop a solution to the problem statement.
- Have students develop a **Claim** that solves the problem statement: Build a house that won't blow away.
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

We claim the 2nd design from Team 2 is the best solution that solves our problem.

Evidence

Team 2 tested this design by blowing on it from all 4 directions as hard as they could. It showed no signs of damage. It was big enough to cover our person. It had a roof and walls. Even though other designs showed no damage, they did move when we blew on them.

Reasoning

Investigation: We are confident in our choice because this design showed no signs of moving. It was very sturdy. We blew on it as hard as we could.

Continued

Science: I learned from books and our discussion that the house must have a flat shape on the bottom to be sturdy. I also learned that heavier, thicker materials make stronger houses.

CREATIVE THINKING

Now that students have experience building "houses" out of unusual materials, take the opportunity to further develop their creative thinking skills with *Off-the-Wall Analogies*. Ask students: *How is a house like a feather? How is a wolf like a house? How is a window like a stone?* These analogies give students practice thinking beyond the obvious.

Evaluation

Students reflect on the investigation.

- Ask students what they might do differently if they did this investigation again.
- Ask students what surprised them.

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Application

Students apply their understanding of building strength in a new context.

- Have students explore these books to further their understanding of wind and/or engineering:
  - *I Face the Wind*, by Vicki Cobb
  - *The Wind Blew*, by Pat Hutchins
  - *How a House Is Built*, by Gail Gibbons
  - *Rosie Revere, Engineer*, by Andrea Beaty
- Encourage students to design and draw their dream house that would be safe from the wind.

Assessment

Evaluate students on how well they:

- designed and built a house that withstood wind.
- communicated the connections between the shape(s) of their house and how it withstood the wind.
- evaluated the performance of houses and used data to describe the strengths and weaknesses of each design.

Take This Lesson Across the Curriculum

There's No Place Like Home

Sometimes we can take for granted the fact that we have a home. Some people have their homes destroyed by fire or floods. Others cannot afford a home. Take a minute to appreciate whatever place you call home! (Note: use sensitivity if you think there may be children in your class who do not have a home.)

Reading/Language Arts	Math	Science	Social Studies
My Home What does your home look like? Draw a picture of your home and use labels to explain information. CCSS.ELA-LITERACY.W.K.2	**Room Count** How many rooms are in your house? How many windows? CCSS.MATH.CONTENT.K.CC.A.1	**Blow the House Down** Learn what makes a house strong and protects it from the wind. NGSS: K-2-ETS1-3	**Where in the World?** Do you know where you are on the planet? Find your home on the globe. NCSS: D2.Geo.1.K-2

Wonders of Wind

Wind is a force around us all the time. Did you know it can be used for good (for example, to fly a kite or produce electricity), but that it can also be destructive (for example, tornadoes and hurricanes)? Study the wind and decide what you think for yourself.

Reading/Language Arts	Math	Science	Social Studies
Reading Time Have students read *Wind*, by Marion Dane Bauer. Build grade-appropriate phonics and word analysis skills with this on-level text. CCSS.ELA-LITERACY.RF.K.3	**Kite Design** Use a variety of shapes to design a kite that you can fly in the wind. CCSS.MATH.CONTENT.K.G.B.6	**Blow the House Down** Learn what makes a house strong and protects it from the wind. NGSS: K-2-ETS1-3	**In Their Own Words** Read letters from survivors of hurricane Katrina. NCSS: D2.His.9.K-2

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

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ENGINEERING DESIGN FORM

BLOW THE HOUSE DOWN

NAME: _____

DATE: _____

Possible Solution	Solution Test/Observation	Data Analysis
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	Damage No Damage	Success? Yes No Keep or Change