Lesson Objective:

How does the natural environment influence the design of buildings? By making specific choices about how to build a structure, architects can best account for the natural weather patterns of a particular climate.

Lesson Description:

Students will apply a scientific investigation process to determine the best building design elements to account for simulated rain, sun and wind conditions in the Northwest or any other climate zone.

Lesson Goals & Assessment Criteria:

Target: Students predict most appropriate design for the building elements (roof, walls and windows) to use in a particular climate.
Criteria: Students examine design elements visually and hypothesize how the design will react to weather condition tests.

Target: Students test design of building elements (roof, walls, windows) using simulated weather conditions of rain, sun and wind.
Criteria: Students confirm and/or revise prediction based on evidence from investigations.

Target: Students select the best overall design for particular climate conditions.
Criteria: Students synthesize evidence from tests and determine which are the best design elements.

Integrated Subjects:
Science
Social Studies

Suggested Grade Levels:
2nd-5th
(See Lesson Adaptations section for use with Upper and lower grades)

Essential Academic Learning Requirements (EALRS):
Science 2.1.1
Science 2.1.2
Science 2.1.4
Science 3.2
Social Studies: Geography 2.2

Lesson Duration:
Up to four one-hour class periods

MATERIALS:
- *4 -5 testing stations (for 5-6 students).*
- *Stations to include the following:*
  -Testing Station Guidelines
  -Blow Dryer, labeled "Wind"
  -Flashlight, labeled "Sun"
  -Watering Can, labeled "Rain"
  -Paper Towels
  -Tape
  -Scissors
  -Protractors
- *Cardboard for Roof and Walls (3"x6", 4"x6", 8"x3")*
- *Clear Plastic for windows (2"x2", 4"x4")*
- *Building Design Elements Investigation Logs #1 and #2 for each student*

This project made possible in part by funding from 4Culture and King County Lodging Tax and the Accent on Architecture Grants Program, supported by grants from the American Architectural Foundation, CNA Insurance Companies and Victor O. Schinnerer & Company, Inc.

THE LESSON:

TEACHER NOTES:

Suggested Pre-Lessons:

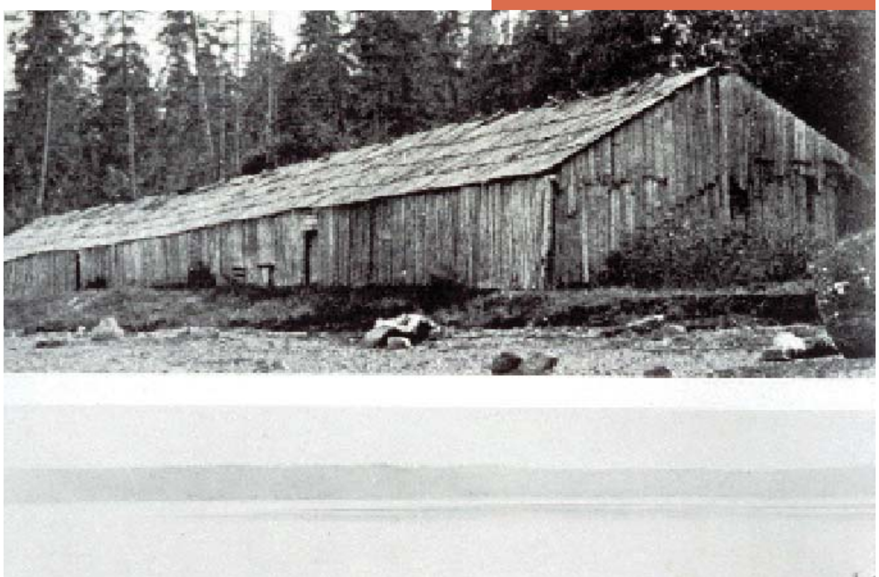
- Have students practice creating basic structures with walls, roofs, doors, and windows using cardboard. This way they will be familiar with materials and construction techniques. Then the students can focus on the adaptations they need to make to the structures.
- Teach about several different climate zones. Have students form small groups, each selecting a zone and researching its weather statistics, (for example, average rainfall, the different weather seasons).

Day One - Effects of Climate on Buildings

Teacher: Introduces the lesson concept: how people build to account for the Northwest climate. Leads brainstorming about the kinds of weather in the region (or discusses other climates the students have already studied).

Prompts: *What is the weather like today? What is the weather like in the winter or in the summer? How do you take account of the weather in what you wear? What is the difference between climate and weather? How does a building in the Pacific Northwest take account of the weather? It can't change its coat, but what do architects do to make a building fit for this climate?*

Students: Participate in brainstorming by responding from personal experience.



Robert Purser

Teacher: Shows three examples of Pacific Northwest architecture on image transparencies: Salish shed-roof house, Craftsman bungalow, and 1960 University of Washington Faculty Club.

Prompts: *How do you think these different buildings take account of Northwest weather?*

1. Salish - Pitched roof and not many openings through which rain could enter.

2. Bungalows - Large porches to keep cover from rain.

TEACHER NOTES:

Seattle Architecture Foundation

3. UW Faculty Club - Large windows to let in light in a dark climate and for views. Wide overhangs to protect from rain and low-pitched roof for run-off.

University of Washington, Special Collections, DM2665

Students: Describe design elements of houses and infer how elements of the houses could relate to the Northwest weather.

Teacher: Shows images of house styles found in other climate zones, such as a Southwestern pueblo, an Alpine chalet, or a yurt. Asks students to specifically compare how the roofs, walls and windows are designed, as compared to the Pacific Northwest houses.

Students: Describe the roofs, walls and windows of other house styles and infer how these elements could relate to different climates.

Day Two – Building Structures for Climate

TEACHER NOTES:

Teacher: Introduces the lesson focus: investigating design elements for weather effects and setting up simulated experiment stations. Hands out materials for constructing "model" buildings.

Prompts: *One major decision architects need to make is how to design the most basic elements of a house – its roof, walls and windows. You will choose a climate zone (maybe a zone that students have already studied). Then you will select a style of building and create a "model" building out of the materials that I give you. Demonstrates considerations and ways to manipulate materials to create a building.*

Prompts: *For my roof, I want to consider the different pitch, or angle, I want to use. You can use your protractor to measure the different angles that you try out. You will want to keep track of these measurements. For the wall, I will consider different heights and widths. I can put these cardboard pieces together vertically to make a tall, narrow house, or horizontally to make a long, wide house. Think about windows and how much light you want to let in. Will a lot of light make the house too warm considering the climate you are in? You can use scissors to change the size of the pieces and tape to tape them together.*


Neil Beer/ Getty Images: Getty donation(RF)

Students: Receive building materials, observe teacher's demonstration, and construct a model house.

Day Three – Testing Structures for Climate

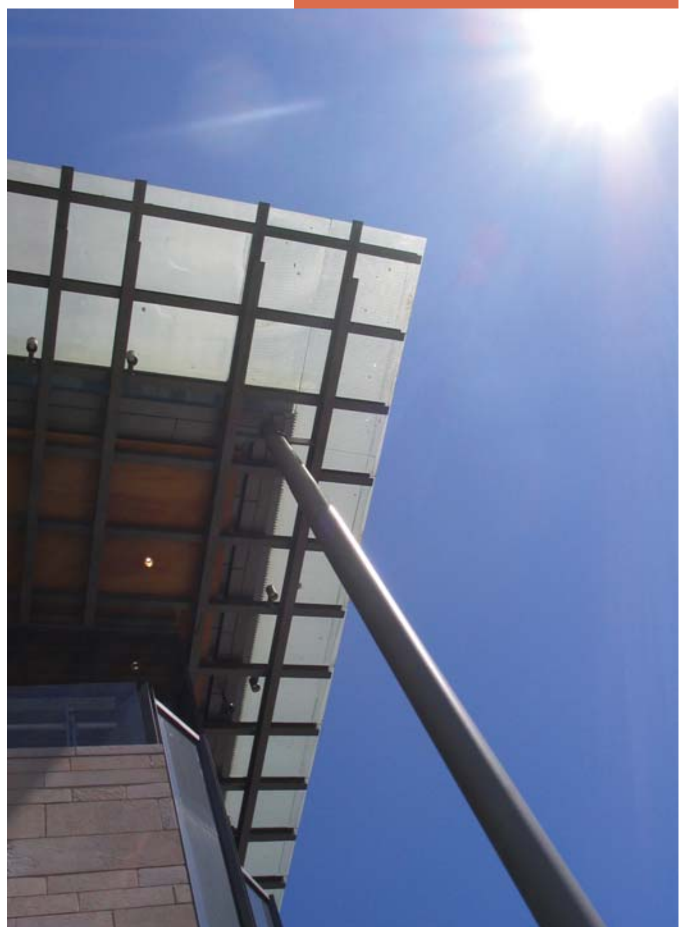
TEACHER NOTES:

Teacher: Introduces testing stations to test design elements under simulated weather conditions. At each station, students can test their building for wind, rain and sun. Review the Testing Station Guidelines. (See next page for Creative Solution!)

Students: Listen to instructions and form small groups to begin investigations.

Teacher: Hands out Building Design Investigation Log #1 and Building Design Investigation Log #2. Guides students to first analyze each building element (roof, walls, windows) by looking closely at it. From this initial investigation, students are to make an educated guess (hypothesis) about how their model building will react to the tests using Log #1. Instructs students to then test their model building and carefully record what they observe on Log #2.

Students: First analyze materials visually and then make a hypothesis. Test hypothesis by conducting a test of the building, according to the testing station guidelines. Record results at each testing station.



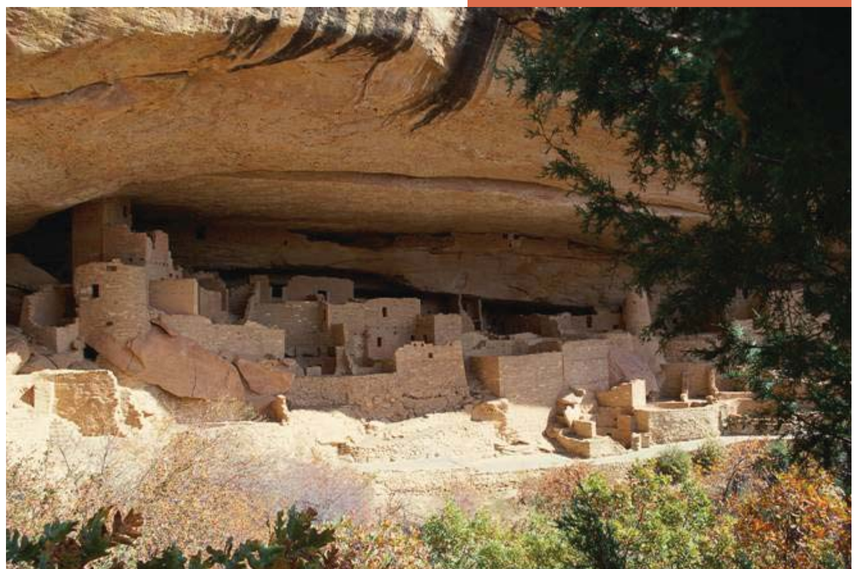
Alan Dodson/SAF

(At this point, the teacher can ask students to bring in materials from home and repeat Instructional Strategies 4 through 6, so students will have additional practice in the investigation process and be engaged in testing their materials.)

Day Four – Analyzing Results of Tests

Teacher: Guides students to compare their initial educated guesses about the materials to the actual test results.

Prompt: *Was there anything that surprised you? Did the results of the test make you change your mind? What changes to your building do you need to make so that it can better account for the climate?*



Photodisc/Getty Images: Getty donation (RF)

Asks students to review the results at the testing station and determine which building design is best suited for effects of rain, sun and wind in the climate they selected. Leads discussion comparing students' decisions.

Prompts: *What are the advantages and disadvantages of your building style for the climate you selected, and what if that building were in Seattle/the city you live in?*

Students: Review results of tests, decide on best building design, compare decisions to classmates', defend their decisions, and present results to the class.

CREATIVE SOLUTION!

Having the students run through the testing stations a few times with different materials gives them data they can use to figure out how to build the best structure for the climate and its weather conditions.

LESSON ADAPTATIONS:

For students grades K-1:

Focus the discussion introducing the lesson more on how students personally accommodate for weather, and how they use or change things in their houses when it is raining, sunny or windy. For example, do they open or shut the windows when it is sunny? When do they use curtains or shades? Younger students can conduct the investigations with more adult supervision. Instead of asking them to analyze the test results individually, lead a discussion with the whole class about what happened to the materials at each station.

For students grades 6-8:

Allow students to design the investigations and consider what available technology they can use to test materials affected by rain, sun and wind.

Have students place building materials (architecture and construction firms can donate samples of these materials) outside to measure the effects of the actual weather on the materials over time.

Have students experiment with alternatives to straight planes for walls, roofs and windows. What if they were to bend the walls, or curve the windows; how might this affect their use in different climates?

SHAPING YOUR COMMMUNITY:

- **At home, students can think about how they account for the weather in the structure in which they live. Are there parts that could be better protected for weather? How are activities planned around the weather (playing, homework, etc.)?**
- **In the community, students can contact their local neighborhood associations and learn more about ordinances that regulate building design. They can also learn more about accounting for the climate through building technologies such as solar energy, rain water collection and windmills, and by visiting places to see these technologies in action.**

ADDITIONAL LESSON OPTIONS:

- Set up testing stations that can stay in the classroom for a while. Encourage students to bring in materials from home or other places to test on their own.
- Research how the building industry currently tests for these weather conditions.
- Test how materials react to other physical forces such as push, pull and load.
- Consider and test other design elements that relate to the Northwest weather, such as size of windows, slope of roof, or size of overhangs and porches.
- Investigate the use of the sun in passive solar architecture and explore the key design elements of passive solar architecture, such as glass on the south facing wall of a building and using materials that absorb and store heat well. Older students can then calculate how various methods of absorbing and storing heat can increase or decrease energy performance.
- Discuss environmental factors other than weather that affect house building such as the location of the house, the topography and local vegetation for landscaping.
- Compare man-made vs. natural building materials. Discuss the differences between current building materials and those available to the Salish people, first settlers of Seattle, or early 20th century materials. How did the available building materials relate to the social and economic structure of Seattle for each time period?

BACKGROUND INFORMATION:

Salish Shed-Roof House

The most common type of Salish structure was the shed-roof house. It consisted of a permanent frame with a removable roof, and wall planks made of western red cedar. For the frame, slab-like posts were set into the ground in pairs of unequal height to form two rows parallel to the shore, with the taller side near the water. The walls of the house were separate from the frame that held the roof. They were slung horizontally between pairs of vertical poles to which wall planks were bound with cedar-withe rope. Inside, the walls were lined with mats of cattail or tule rushes. The floors were bare earth. The shed-roof house was actually a sequence of modules that could be added whenever new households married into the family. The leader of the family would live in the central, largest unit, and the houses might grow in both directions. The more important family members would live closer to the center.

Craftsman Bungalow

This style of house was one of the most common middle-class housing designs from 1910 to the 1930s. Craftsman refers to the movement in American architecture away from the machine-made extravagances of the Victorian Era. There was a desire for simpler times where craftsmanship was valued. In architecture, structured detail and the use of good materials was prized over applied ornamentation. “Bungalows” are traditionally low houses with wide roofs and deep porches. The American bungalow had its roots in California, where it was well suited to the warm climate. As the style spread, adaptations were made to accommodate building resources and climate. One-level living was a practical solution for many middle-class Americans who were just becoming financially able to move from one-level apartments into their first houses.

University of Washington (UW) Faculty Club

This building, which won a 1960 AIA award, is a regional interpretation of the principles of modern architecture. Generally, modern architecture is a minimalist style and stresses the function of the building over decorative details. Typically, this style emphasizes the horizontal aspects of the building. For the UW Faculty Club, architect Victor Steinbrueck, with Paul Hayden Kirk & Associates, have drawn the focus to the long row of windows along one side of the building. The windows allow for the maximum amount of daylight in the typically gray Seattle climate.

Chalet

A wooden dwelling with a sloping roof and widely overhanging eaves common in Switzerland and other Alpine regions.

List of Images:

- Salish Shed Roof House
- Craftsman Bungalow
- UW Faculty Club
- Chalet
- Seattle City Hall: Sunshade
- Pueblo dwellings

Images for each unit can be found on the SAF website @ **www.seattlearchitecture.org**

Related Lesson Plans:

Nature’s Impact on Buildings. 5th grade Science, Schoolyards to Skylines: Teaching with Chicago’s Amazing Architecture. Chicago Architecture Foundation, 2002

Design Your Own Park Lodge, Great Lodges, PBS Teaching Guide, http://www.pbs.org/opb/greatlodges/teachers/poppa_design_lodge.htm

Designing a Desert House, The Art and Science Connection: Hands-on Activities for Intermediate Students by Kimberley Tolley, Innovative Learning Publications, 1994

Building Big Educators Guide. Building Big, PBS Teaching Guide, http://www.pbs.org/wgbh/buildingbig/index.html

Websites:

Archkidecture, Building Materials, http://www.archkidecture.org.

Seattle City Hall

A new City Hall opened in Seattle in 2003. It was designed to be an important public landmark representing Seattle's open and accessible government. It replaces the Municipal Building which was not earthquake safe. The site of the Municipal Building will become a landscaped Civic Plaza. City Hall now houses the Mayor's Office, the City Council Offices and Chamber, and key customer services.

Pueblo

A communal dwelling, usually made of adobe (unbaked mud brick dried in the sun, often containing chopped straw and pounded earth as a reinforcement), and most commonly built by Native Americans in the southwestern United States. Pueblos were often built into the hollows of cliff faces or built one above the other with thick mud-brick roofs. This provided thermal protection in the hot summer months.

VOCABULARY:

Analyze - To examine methodically by separating into parts and studying their interrelations.

Climate - The meteorological conditions, including temperature, precipitation and wind that characteristically prevail in a particular region.

Hypothesis - A tentative explanation for an observation, phenomenon or scientific problem that can be tested by further investigation.

Investigate - To observe or inquire into in detail; examine systematically.

Materials -The substance, or substances, out of which a thing is, or can be, made.

Opaque - Impenetrable by light; neither transparent nor translucent.

Pitch - Angle of a roof.

Result - The consequence of a particular action; an outcome.

Siting - To locate a building so that it makes maximum use of natural and topographical resources.

Simulated - Made in resemblance of, or as a substitute for, another.

Transparent - Capable of transmitting light so that objects or images can be seen clearly.

Date: ___________________________

Student Name: ____

Scale

1 - Well below target
2. - Approaching target
3 - Meeting Target
4 - Exceeding Target

Teachers: Indicate assessment in each target area by circling the number that best describes student's participation.

Predict				
Examines building elements visually	1	2	3	4
Hypothesizes how building elements will react to tests	1	2	3	4
TEACHER'S COMMENTS:				

Test				
Confirms and/or revises predication based on evidence	1	2	3	4
TEACHER'S COMMENTS:				

Select				
Evaluates the best building design based on evidence	1	2	3	4
TEACHER'S COMMENTS:				

Lesson Goals & Assessment Criteria

Target: Student predicts most appropriate design for the building elements (roof, walls, windows) to use in a particular climate.

Criteria: Student examines design elements visually and hypothesizes how the designs will react to weather condition tests.

Target: Student Tests design of building elements (roof, walls, windows) using simulated weather conditions of rain, sun, and wind.

Criteria: Student confirms and/or revises prediction based on evidence from investigations.

Target: Student selects the best overall design for particular climate conditions.

Criteria: Student synthesizes evidence from tests and determines which are the best design elements.

CHECK YOUR WORK!

Student Name: ______________________________ Date: __________________

Give yourself a check, if you completed the tasks below to the best of your ability.

Did I ......?

	✔
Examine the building elements (roof, walls, windows) visually?	
Hypothesize how building elements will react to tests?	
Confirm and/or revise prediction based on evidence?	
Evaluate the best building design based on evidence?	

These tasks were the most challenging for me:

	✔
Examining the building elements (roof, walls, windows) visually.	
Hypothesizing how building elements will react to tests.	
Confirming and/or revising prediction based on evidence.	
Evaluating the best building design based on evidence.	

These tasks were easy for me:

	✔
Examining the building elements (roof, walls, windows) visually.	
Hypothesizing how building elements will react to tests.	
Confirming and/or revising prediction based on evidence.	
Evaluating the best building design based on evidence.	

TESTING STATION GUIDELINES

Wind
1st Step: Place a blow dryer (set on "low") directly above your model building.

- •While one student holds the building model, the other student moves his or her hand around the building to feel where the wind is coming from.

- •Move the blow dryer around the building model to test the wind coming from different directions.

Sun
1st Step: Make sure there is a flashlight at the station.

- •Shine a flashlight through the windows. Determine how much light is coming into the interior of the building model.

- •Move the flashlight to simulate the sun at different times of the day.

- •Cover up windows to test if the building model feels warmer or cooler inside when there are fewer windows.

Rain
NOTE: CONDUCT THIS TEST LAST
1st Step: Make sure the water can has water in it.

- •Use the water can to "shower" the building model.

- •Note if water stays on the roof or runs off quickly.

LOG #1
Building Design Elements Investigation

Hypothesis - From what I can observe, how will this building hold up to the wind, sun, and rain?

I am building for this climate: Alpine Chalet

	Roof	Walls	Windows
Describe your building:	High pitched roof.	Tall and narrow.	Small windows, one above the other.
Wind	Won't blow the house too hard, because the roof is so narrow.	Wind will whip around the walls, but might shake the house because it is tall.	Because there are a lot of windows, the wind might rattle the windows and make the inside of the house cold.
Sun	Wide overhangs on the roof can provide shade from the sun.	Because the building is tall, heat will rise up and make the top floors very hot.	Lots of windows will let sun in on cold days, and can be opened for breezes on warm days.
Rain	Rain (and snow) will run off the roof because it is steep.	No major effect from rain.	With so many windows they might leak.

LOG #1
Building Design Elements Investigation

Hypothesis - From what I can observe, how will this building hold up to the wind, sun, and rain?

I am building for this climate:____

	Roof	**Walls**	**Windows**
Describe your building:			
Wind			
Sun			
Rain			

LOG #2
Building Design Elements Investigation

Testing - Describe the results of testing the roof, walls, and windows for rain, sun, and wind conditions. Make careful observations.

I am building for this climate:____

	Roof	**Walls**	**Windows**
Describe your building:			
Wind ***Will it blow over?***			
Sun ***How hot will it get?*** ***How much light will it let in?***			
Rain ***How wet will it get?***			

LOG #2 - (continued)
Building Design Elements Investigation

What are your conclusions? Please answer the following questions.

Which of your testing results were very different from your hypothesis or predictions?

Based on the results of your tests, what changes would you make to your building design?

How would these changes make the building better for the climate it is in?