

Raising the Roofs

Math, social studies, science, language arts

SKILLS.....Knowledge, comprehension, application, analysis, synthesis, evaluation

STRATEGIES.....Classification, discussion, problem solving, research skills,
scientific inquiry, using scale

DURATION.....2 class periods, 2- to 3-hour field trip to Aztec Ruins

CLASS SIZE.....Any; in groups of 2 or 3

OBJECTIVES

In their study of prehistoric roofs at Aztec Ruins, students will use the scientific method to:

1. Draw a map of a prehistoric roof in the West Ruin, labeling materials used, and using compass, measuring tape, and graph paper.
2. Investigate the origin of and materials used in prehistoric roof construction.
3. Test and assess a hypothesis that helps answer a question about roof construction.

MATERIALS

- Graph paper, metal tape measure, ruler, compass, pencils, and step stools for each student group
- Maps of the Four Corners region
- Topography maps

Optional

- CD-ROM program “U. S. Atlas,” found on *Mindscape For Multimedia* for IBM PC and compatibles
- Computer with CD-ROM drive, drawing program, and word processor

VOCABULARY

classification: systematic arrangement in groups or categories according to established criteria.

data: information, especially information organized for analysis.

dendrochronology: determining the age of a tree by counting its rings; the study of tree ring dating.

hypothesis: a proposed explanation accounting for a set of facts that can be tested by further investigation.

inference: a conclusion derived from observations.

juniper splints: thin layers of juniper placed above the latillas and below the dirt layer on a roof.

latilla: cottonwood or aspen pole placed above the vigas and below the juniper splints in a roof.

viga: a log of spruce, Douglas fir, ponderosa pine, or juniper used as the primary support beam for a roof.

BACKGROUND

This lesson, as presented, may be too complex for lower grades. Teachers can simplify and reduce the time needed by undertaking just a portion of the lesson, or by omitting computer use. Refer to number 4 in EXTENSIONS at the end of this lesson for ideas on how to use portions of this plan.

Archeologists answer questions about people who lived in the past. They use the scientific method to guide them in their research. It involves observation, inference, hypothesis development, and procedures to test the hypothesis. After making observations based on what an archeologist can readily see, he/she proposes *inferences*, or reasons, to account for an observation. A *hypothesis* is an inference that the archeologist chooses to confirm or disprove through testing.

This lesson guides students through testing and evaluating a hypothesis that addresses this research question about roof construction: "How much time and energy did the people at Aztec invest in constructing the roofs?"

Although there could be many ways in which an archeologist might go about answering this question, he/she would need to make some initial observations and inferences, and then develop a hypothesis. A hypothesis chosen for testing in this lesson is: "If the wood used was not available in the local area, then builders must have transported it."

He/she would conduct research to test the hypothesis. Part of the research would involve investigating and classifying the materials they used into species of wood, size, and amount used, and observing how they were used in construction. He/she would need to determine the likely source of the wood, then classify the wood into categories of "easy to obtain" (locally available, easy to use, easily transported) or "difficult to obtain" (not locally available, difficult to transport.) Based on the research, he/she could reject, accept, or revise the hypothesis,

and evaluate its relevance to the original research question.

The interpretive trail at Aztec Ruins passes through several rooms in the West Ruin with intact original roofs, where we can observe details of construction, determine amounts of material used, and identify wood species. The science of tree-ring dating, or *dendrochronology*, not only enables archeologists to identify wood species, but also helps determine cutting dates for some species of wood, such as fir, Douglas fir, spruce, and sometimes ponderosa pine and juniper. Cottonwood and aspen rarely yield cutting dates. Cutting dates and species identification can tell archeologists the years and seasons in which wood was collected, how often structures were repaired, and how far builders traveled to obtain wood.

Analysis of wood samples shows that builders used various species of wood in roof construction. The large support beams, or vigas, are of fir, Douglas fir, spruce, and sometimes ponderosa pine or juniper. The smaller poles above the vigas, called *latillas*, are made of either cottonwood or aspen – scientists are unable to tell which because they are so closely related. Above the latillas are short sections of split juniper, called *juniper splints*. These are in turn covered by packed dirt, which serves as the floor of the room above.

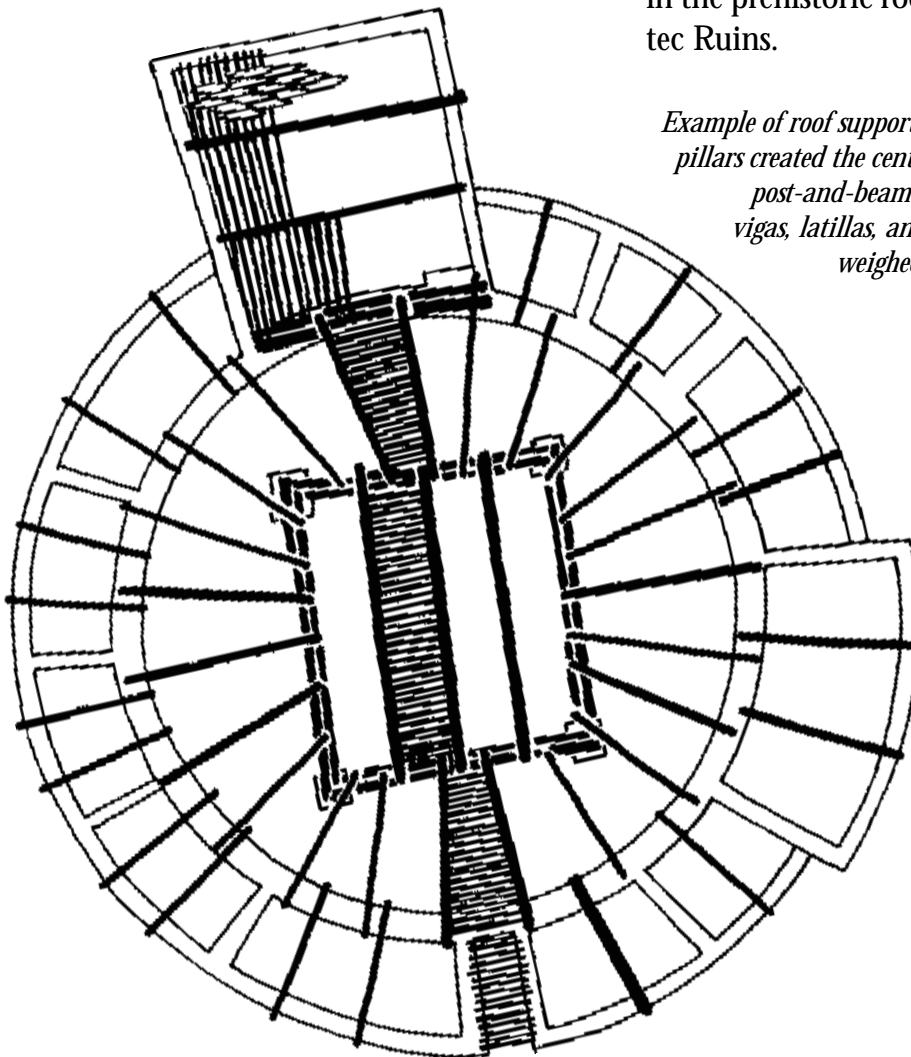
Both juniper and cottonwood could have been obtained nearby. However, other species grow in moister, higher elevations, and would have been transported from at least 20 miles away, depending on the species.

Transporting wood from distant sources was a challenge. Most archeologists believe that the wood was carried by hand, because there is no evidence for wheeled carts or beasts of burden. Some believe logs were floated down rivers, while others believe this was impractical. There are remnants of "roads" running far across the region in straight lines and connecting major sites – but their function is uncertain. Some archeologists suggest that they were used as routes for hauling wood.

SETTING THE STAGE

1. Ask the students to look up at the classroom ceiling and observe and name the materials used for its construction.

2. Pose the question: "How much time and energy did the builders invest in constructing this roof?" Using the background information as a guide, make observations about the roof construction, and discuss possible classification of the roof materials to help answer this question. Examples: easy to obtain, hard to obtain, easy to use, difficult to use.
3. Tell students that they will conduct field research at Aztec Ruins and work with a hypothesis to help answer this question: "How much time and energy did the builders invest in constructing the roofs?" Share the background information with the students regarding the diversity of species used in the prehistoric roof construction at Aztec Ruins.



Example of roof support for great kiva. Four large pillars created the central square. Radial pattern post-and-beam construction supported the vigas, latillas, and juniper splints. The roof weighed an estimated 90-95 tons.

PROCEDURE

1. Divide the class into several teams of three to six students.
2. Distribute graph paper, compass, ruler, and measuring tape to each team. If step stools are available, distribute one per team.
3. Take the field trip and complete the following assignments. First, show students the vigas, latillas, and juniper splints on the visitor center ceiling to make sure they can identify them.
 - Each team chooses a room on the interpretive trail that has a roof.
 - Each team uses the tools given to them to draw a map of the roof. Use the compass to orient the roof in the proper direction. Use the tape measure to measure and record the size of the room, length and size of the logs, and spaces between logs.
 - Use a legend to label the vigas, latillas, and juniper splints on the map.
4. Write the research question on the board: "How much time and energy did the people at Aztec invest in constructing the roofs?" Share the BACKGROUND information relating to archeologists' use of the scientific process, and review the definition of a hypothesis.
5. Introduce the following hypothesis that can help answer this question: "If the wood used was not available in the local area, then builders must have transported it."
6. Ask the students to suggest ways they can prove or disprove the hypothesis. Examples: determine which wood species used to grow in the local area; determine if enough of a species grows in the local area.
7. Review the background information regarding the different wood species used in roofs. Students research the environmental conditions (altitude, precipitation, soils) under which each species naturally grows.
8. Students use reference books to infer the closest origin for each species of wood used in the roof construction. If a computer is available, access the program "U.S. Atlas" on *Mindscape* CD-ROM to research the information.
9. Based on the research, classify the wood types into categories of "difficult to obtain" and "easy to obtain," where easily obtainable materials would be available within a five-mile radius.

CLOSURE

Review the hypothesis. From the research conducted, evaluate it. Revise the hypothesis if necessary. Discuss the extent that research of the hypothesis helped answer the original question, "How much time and energy did the people at Aztec invest in constructing the roofs?"

EVALUATION

Students are evaluated for their maps and participation in class discussions.

EXTENSIONS

1. Using their maps of the roofs, students determine the number of linear feet of each species needed for the construction of their roof. Discuss as a class, or in small groups of students, how much wood was required for building the entire structure. (There are about 450 rooms in the West Ruin, each requiring a roof.)
2. On a computer, students make a representation of their roof using the draw program.
3. Make inferences regarding how wood for the vigas were transported from higher elevations to the building area. Example: wood was carried using wheeled carts over roads, logs were floated on rivers. Develop a testable hypothesis from one of the inferences, then discuss the research needed to help test it. Example: If the builders transported them via rivers, then the logs should show evidence of wear from being knocked by other logs as they traveled down a river. Test by closely examining vigas for evidence of this kind of wear.

4. For lower grade levels or teachers less experienced in scientific inquiry, use portions of this lesson as separate lessons. For example, one lesson could focus on mapping a modern ceiling and a prehistoric ceiling (OBJECTIVE 1, PROCEDURES 1-3). Another lesson could investigate the origin and transporting of roof materials (PROCEDURES 7-9, EXTENSION 3). To shorten further, share the background information regarding environmental conditions under which different species grow instead of having students research this. Another lesson could focus on roof construction and computer simulation (PROCEDURES 1-3, EXTENSION 2).

REFERENCES

- A Trailguide to Aztec Ruins*, Southwest Parks and Monuments Association, Tucson, 1994.
- Lekson, Steve, et al., The Chaco Canyon Community, *Scientific American*, Vol. 259, No. 1, pp 100-109, July 1988.
- Morgan, William N., *Ancient Architecture of the Southwest*, University of Texas Press, Austin, 1994
- Nabokov, Peter and Easton, Robert, *Native American Architecture*, Oxford University Press, New York, 1989.
- Flowers, Shrubs and Trees of the Southwest*, Southwest Parks and Monuments Association, Tucson.

