

Energy Efficient Southwestern Style Homes

Jessie Barreras

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Purpose

While studying the architecture and culture of the Southwest I have gained a new respect for many of the cultural aspects around me that I have always ignored or taken for granted. As well as learning science and architecture, I hope that my students will also gain new respect for this Enchanted Land.

The primary objective of this unit is to teach physical science with Southwestern Architecture as the mode for discovery and learning. The Energy and Southwestern Architecture unit is interdisciplinary in that it covers a wide range of learning skills with context and concepts in art, physical and life science, math and social studies. I want my students to enjoy science and learn how scientific concepts apply to everyday life. Southwestern architectural concepts are an excellent way for students to learn how ancient and modern man harnessed available materials and the sun to provide energy efficient homes. The written curriculum is intended to enrich a unit on Energy. Students will already have a working knowledge of basic energy concepts. Activities introduced will spark an interest in Architecture and other trades that complement it as possible future professions. Students will also be required to keep a journal with notes and

drawings which will be turned in at the end of the unit. Depending on how the unit is used, the amount of time it takes depends on how in-depth the teacher wants to get into each discipline. For example, the unit can be expanded to include a more in-depth historical study of local areas with detailed research papers on specific cultural groups. The tangents which this curriculum can lead to are limited only by the teacher's imagination and abilities. Students will gain a working knowledge of the physics of building design, model construction, and energy conservation as a final outcome.

Classroom Design

The best way to facilitate an activity-oriented class is to keep the room in a Lab Style setting. By doing this you will not have to rearrange the room from a traditional setting to a lab setting every time your class does an activity. It is important to have permanent storage areas for supplies as it will save much preparation time. (See Figure 1.)

Visual Overview Of Unit -- Display Board

A student overview display board is very useful. At the beginning of the unit the instructor will display and explain a visual outline of the unit. The display board will remain posted the entire unit. Students will be able to refer to the outline in order to find out where they are in the unit, what is expected, and what they will be doing next. Each section of the unit will have a representative picture or sketch with a short explanation to accompany it. Explanations will contain expected behavioral objectives and possible credit to be earned. This method of overview meets the needs of visual, spatial, auditory and verbal learners. (See Figure 2 for a suggested design of the display board.)

Lesson Plan -- Introduction To Floor Plans And Drafting Student's Homes

The purpose of this lesson is for students to learn how to read and draft basic house plans. They will start with lead up exercises which will gradually become more complex. This will allow students to have a clear basic understanding of floor plans which will help them plan and design their final project. There are three parts to this lesson: Bubble diagrams, a rough floor plan of the student's home, and a detailed floor plan of the student's home.

Materials: pencils, drawing paper, architects tracing paper, 1/4 in. graph paper.

Bubble Diagram

Have each student draw a bubble diagram of his/her home by memory. They are to draw a representative bubble for each room in the house. Students are to take their bubble drawings home and make changes on tracing paper laid over their original diagram. They are to add all living areas such as hallways, closets, laundry rooms etc.

See Figure 3 for example.

Rough Floor Plan Of Student's Home

Students are to place a second sheet of tracing paper over their bubble diagram. They are to measure all the rooms in their home and note it on the top sheet of tracing paper. Using this information, students are to draw a rough draft of their homes on graph paper. Rooms should be labeled. This draft is to include only the walls of the home. Each square is the equivalent of one foot. (See Figure 4.)

Detailed Floor Plan of Student's Home.

Procure about six sets of professionally drafted house plans. Display plans in an easily accessible area for student viewing. Explain the details you want students to include in their homes such as windows, doors, cabinets, vents, stairs, etc. Point out how these items are drawn into the plans. After viewing and discussing professional plans, students are to draw up a detailed plan of their homes including as much detail as possible. They are to include a legend, compass and notes on their draft.

Lesson -- Heating Systems For The Southwest Climate

The purpose of this lesson is to identify types of heating systems and explain their differences. This lesson will be taught in a lecture and visual format. Students will be able to use this information when designing their southwest energy-efficient homes.

Heating Systems: Although solar heating systems are becoming more popular, most homes today have central heating systems. A central heating system generates heat for an entire building from one central location then delivers it where it is needed. Based on how the heat is delivered, the systems are divided into two main groups: direct and indirect systems. Direct systems circulate warm air throughout rooms to be heated. Indirect systems circulate hot water or steam to converters or radiators which give off heat in areas to be heated. Some types of fuel used for this system are natural gas, fuel oil, electricity, propane, wood, and the sun. Explanations and illustrations of some heating systems follow.

Convection Hot-Water And Steam Heating Systems

This system consists of a network of pipes and converters connected to a water heater. Hot water is piped from the heater to a converter in each room. The hot water heats up the converter which gives off heat into the room, warming it by convection currents. The water in the converter returns to the heater after it cools. (See Figure 5.)

Radiant Hot -Water And Electric Heating Systems

In the hot-water system, water is heated the same way as in a convection system then transferred to a continuous coil of pipe in the floor of each room. Heat radiates from the pipe and warms the room. The electrical system heats coils like those in a toaster. The coils can be placed in the floor, walls, ceilings or baseboards. The heated coils then warm the room by radiation. (See Figures 6 & 7.)

Warm-Air Heating Systems

Today, most homes are heated by forced-air systems. Although they are the most inexpensive systems to install, they are not the most economic to use. This system works by heating air in a furnace then forcing it through ducts to vents with a blower. As the warm air enters the room, it heats the surrounding cooler air. As the air cools it returns to the furnace through different ducts which remove dust from the air with a filter. (See Figure 8.)

Solar Heating Systems

Solar heating systems use the energy from the sun to produce heat. The southwestern climate is ideal for this type of heating system. There are two types of solar heating systems: active and passive. (See Figure 9.)

The active solar heating system uses a solar collector to collect and store heat. Special tubing passes through the collector with water or some other liquid circulating through it. The collector heats up when sunlight strikes it. The collector heats up the liquid passing through the tubes. The liquid goes into a storage tank where it is pumped through pipes to heat the building or the air blown into the building. On cloudy days the solar collector cannot absorb enough energy to produce heat, so a backup system is used instead.

The passive solar heating system heats buildings with direct radiation from the sun. In order to get the best advantage of the sun's power, the building's windows and orientation must be carefully planned. The best angle of orientation of the building will differ according to its location. There are many styles of passively heated buildings, and most all of them have backup systems when there is not enough sunlight available.

Activity #1 -- Surfing The Internet For Solar Heating Ideas

The purpose of this lesson is for students to find different examples of solar heating systems which they can incorporate in their final project designs. Also, this activity will allow students to practice searching for information on the web.

Schedule a block of time at your school's computer lab, and advise the computer technicians about what information you will be looking for. Do an initial search so you can compile a list of internet addresses that students can start off with. Have students make copies of different solar heated buildings to display in the classroom. Also have students write a short explanation of their pictures.

Activity #2 -- Multiple Day / Station Lab

The purpose of this multiple days/stations lab is to allow students to work at different activities in small groups or individually. Students will learn how passive solar heat works, and how insulation prevents heat loss. They will also practice using the internet for research and learn how to draw an elevation of a floor plan. Students will also have the opportunity to take responsibility for their own education. This method of teaching allows the instructor time to give students who need it individual attention while other students are working at self - guided tasks.

Take a day before you start the labs to explain what is expected of the students, how to do the labs, and how and when to move to the next lab station. Have all the lab stations set up and ready to go while you are demonstrating and explaining to the students what to do. Have a clear and simple list of directions of each lab posted respectively so students can easily refer to them. Divide the class into four equal groups. Assign each group a station to start at. During the entire period, students are to stay at their assigned lab station and not browse around at other stations. Have an extra-credit activity table to keep students who finish their work early occupied, otherwise they might distract other students who really need the entire period to finish their assignments. After all the labs have been done, conduct a class discussion and evaluation of the labs.

Station 1 -- Passive Solar Heating Lab (Adapted from Integrated Science Activity Book, Prentice Hall)

Students are to work in groups of two. Students will build a simple model of a passive solar heater and find out how it works. Have an example of how the box should look on display.

Materials: two shoe boxes per group, clear plastic wrap, tape, a mat knife or scissors per group, two thermometers per group.

Procedure:

1. Cut a window on the small side of each box.
2. Tape a piece of clear plastic on the window. Be sure to completely seal the plastic.
3. Place the lid on the box. Poke a hole in the top of the box so that the thermometer can snugly be pushed through it. Tape the thermometer around the hole to seal it.
4. Place both boxes in direct sunlight. If it is cloudy outside use a sun lamp.
Position one box so that its window faces the sun and the other box with its window facing away from the sun.
5. Predict which house will get warmer. Why?
6. Record the temperatures in each box every 10 minutes for 30 minutes.
7. Answer the following questions. a. Which box got warmer? b. Was your prediction proven correct? c. Based on your observations, how do you think the windows of a house should be oriented to get the greatest benefit from solar heating?

Station 2 -- Testing Insulating Materials (Adapted from Integrated Science Activity Book, Prentice Hall)

The purpose is for students to learn about insulation. Students will compare different materials to see how well they conduct or insulate. They are to work in groups of two.

Materials: pot, Bunsen burner with stand, graduated cylinder, styrofoam cup, three 500ml. beakers, three different types of insulating materials, thermometer.

Procedure

1. Read the following article on insulation.

Once a building is heated, the heat will quickly escape the area if it is not properly insulated. Insulation materials prevent heat loss because they are poor conductors of heat. They reduce heat transfer that occurs by convection and conduction. When a building is well insulated, it stays comfortable in the summer as well as the winter by keeping heat in during the winter and heat out during the summer.

Many materials such as glass, wood, plastic, asbestos, fiberglass and dead air space are poor heat conductors and therefore good insulators. One of the most efficient insulators is dead air space. There are many products that employ methods to best incorporate insulating air space. Fiberglass, a common insulation material, consists of long, thin strands of glass packed together with air spaces between the strands. The air and glass work together as poor conductors of heat. Down jackets work the same way by trapping air between the feathers to prevent body-heat loss. Wood and plastic handles are used on cooking utensils. All newly built buildings are required to be insulated. This cuts down on energy costs and fuel waste. Insulation materials are packed in walls, between ceiling and roof, around pipes, and along the outside of floors. Asbestos is not used in new construction because of health hazards. Weatherstripping is another form of insulation because it prevents heat loss by closing off spaces where heat can be transferred by convection. Double-pane window glass uses dead air space to prevent heat

transfer by conduction.

2. Fill three beakers with 300ml. of boiling water each.
3. Record the temperature of the water in each beaker.
4. Wrap a different type of insulation 2 cm. thick around each beaker and label them A, B, and C.
5. Take the temperature of the water every 15 minutes and record the information in a data table.
6. Use the data gathered to answer the conclusion questions.
 - a. Which material is the best insulator? Why?
 - b. Why are good insulators important for energy conservation?
 - c. Is this material being used for insulation anywhere? If so, where?
 - d. Do you think the insulating materials you tested could be used to insulate buildings? Why or why not?
 - e. Do you think the government should require people to insulate their homes?

Station 3 -- Searching The Internet For Alternative Energy Resources

The purpose of this lab is for students find alternative energy resources which they can include in their final project if they choose to do so.

Procedure

Make arrangements with the computer lab to use four computers for four days. Send students to the lab when it is their turn at that station. Make sure there is a lab technician in the lab to monitor and help students who need it. Students are to gather information on at least three types of alternative energy resources.

Station 4. -- Elevation Drawing (Adapted from Architecture and Children)

The purpose of this activity is for students to learn how to draft an elevation drawing of a floor plan. Students will also learn how to use an architect's scale. They will be able to use this skill when working on their final project.

Procedure

Students must know how to use an architect's scale before doing their elevation drawing. Use the lesson "Using An Architect's Scale" from the *Architecture And Children Teachers Guide*, page 60. Post an example of an elevation drawing for students to refer to. Students are to use the floor plans of their homes that they did in an earlier lesson. They are to draw a front, back, and side elevation of their floor plan. Students should use an architect's ruler to determine the height of doors, windows and roof. Show students how an elevation is drawn by tracing the lines up from the corners of the house plan. Have students sketch in the texture of the walls. Have them pin up their elevations for viewing and evaluation.

Activity #3 -- Perspective Drawings In Class

Overview

Perspective drawing is a technique that allows us to represent three-dimensional objects and space on a flat surface or plane. The foundation of a good drawing is not how it is shaded but the correctness of perspective of the form and the depth of the objects portrayed. In single-point perspective we are viewing the object from a straight-on approach. In two-point perspective we

are viewing it from an angle.

Objective

Students will learn the basics of one- and two-point linear perspective.

Vocabulary

Subject, picture plane, horizon line, vanishing point.

Materials

Drawing board, blank paper, straight edge, triangle, thumbtacks, string.

Procedure

1. Explain and demonstrate how to draw one and two point perspective. Almost any school library will have books on perspective drawing, however, an excellent book with several exercises on perspective drawing is *Perspective* by William F. Powell, published by Walter Foster Publishing.
2. Display various perspective drawings around the room for viewing. (See Figure 6 for basic examples.)
3. Students are to practice drawing one point perspective until they get the hang of it, then go on to two point perspective.
4. Display everyone's drawings on the walls and have students discuss and critique each other's work.
5. For homework have students draw their home or something in their yard in perspective.
6. Students are to draw in perspective an imaginary street with several buildings, including windows and doors.

Activity #4 -- Perspective Drawings In Halls And Outside Of Classroom Of Southwest Design

After students have had ample time to practice perspective drawings in the classroom and at home they will attempt to draw buildings and hallways on the school campus.

1. Provide students with clipboards or other stiff surfaces to support their drawing paper.
2. Send students out to specific places on campus. Coach students on what you want them to attempt to draw. Point out key features that you want them to recognize. Students are to label the type of perspective drawing they are doing at the bottom of their papers. Also give students time limits at each station or they will take too much time trying to make their sketches perfect.
3. Emphasize that their drawing are rough drawings showing the subject, vanishing point, picture plane, and horizon.
4. Have students display their work on walls to do a class critique.

Introduction To Pueblo And Spanish Colonial Style Homes

We live in a world of modern technology. With a flick of a switch we have instant climate control of our environment. Unfortunately, there is a high cost for this luxury. Earth will run out of fossil fuels much sooner than need be if future generations are not educated on how to conserve energy and use the free resources nature provides such as solar, wind, and hydrothermal energy.

Our southwestern ancestors, the Anasazi, show us how easily and efficiently natural resources can be harnessed by architectural design and orientation of their homes to the elements. Spanish Colonial designs which come at a later time also make use of natural resources.

The architectural designs of John Gaw Meem have a glorious presence on the University of New Mexico campus and the Santa Fe Plaza. His wholehearted efforts to design buildings with the graces of Pueblo and Spanish Colonial characteristics are unequaled.

Science being the focus of this curriculum, the history of Southwestern Architecture will focus mainly on how the structural design facilitates the intended function. However, I strongly suggest that collaboration with a social studies teacher be made so that other aspects of our southwestern ancestors can be studied and appreciated in more depth. Listed in the bibliography are several books you can use to become more familiar with southwestern indigenous architecture. However, *Architecture And Children Southwest* printed by the University of New Mexico Printing Press, presents a broad spectrum of lessons on this subject. The lessons come in poster form which are easy for teachers and students to understand. Included in the posters are goals, concepts, great visuals, southwest history, activities and teaching strategies. The titles of the posters are:

1. Origins of Southwest Architecture
2. Spanish Colonial Architecture
3. Architectural Aesthetics
4. Architectural Details
5. Eco-Architecture
6. Southwest Cities
7. John Gaw Meem
8. Frank Lloyd Wright

Lesson Plan -- Slide and Poster Show Of Pueblo And Colonial Style Homes

This lesson is used to introduce students to Pueblo and Spanish Colonial buildings so that when they go on a field trip to actually see them, they will have an understanding of what is being looked at. It is suggested that the instructor take some slides of various historic buildings in such areas as the University of New Mexico, Santa Fe Plaza, Albuquerque Old Town Plaza and local pueblos. Sketches and drawings can also be rendered from various books listed in the bibliography. Slides of the previously listed areas may also be obtained for a reasonable price from Sarbo Color Slides, Box 5171, Albuquerque, New Mexico 87185. Use the information supplied in the introduction to Pueblo and Spanish Colonial section of this curriculum as a base for your information.

The instructor should include slides and pictures that show both early and late Pueblo and Spanish colonial homes as he/she points out and explains the following points.

Pueblo Dwellings

1. Show and explain the solar gains of the dwellings achieved by the orientation. (See Figure 11)
2. Show and explain the structure and function of the different levels and rooms. (See Figure

- 11)
3. Show and explain how as time goes by the addition of windows and doors are affected.
 4. Include pictures and explanations of how the entire community is oriented and why. Describe the structure related to the function of the different dwellings

Spanish Colonial

Basically repeat the procedure used for pueblo dwellings.

Activity 5 -- Field Trip To University Of New Mexico And Museum Of Anthropology To Draw Southwest Details And Study Ancestral Habitats

This field trip will be divided into two parts and will last an entire school day. Students are to take a sack lunch to be eaten at the duck pond at noon. The first part of the field trip will be a guided tour of historic university buildings to study the architectural style and to sketch some of the buildings. After a lunch break, students will visit the Maxwell Museum of Anthropology for short lectures and demonstrations of ancient pueblo living given by the docents of the museum.

Historic Buildings Tour

1. A history of the work by John Gaw Meem should be reviewed a day before the field trip. The importance of his influence should be discussed. Emphasis should be placed and slides shown on UNM campus buildings he designed. Slides of some major buildings in Santa Fe such as the La Fonda Hotel, the Cristo Rey Church, and the Laboratory of Anthropology should also be included, because many students will have the opportunity to see them at some time in the future.
2. Obtain copies of the "University of New Mexico Walking Tour for Kids." Get enough copies to supply one for every two persons. Go over the booklet to familiarize students with the aspects you plan to use from it. Specify what you want students to do.
3. Upon arrival, students are to be divided into groups no larger than six with an adult chaperone for each group. It is necessary to have adult chaperones in order to monitor students' behavior and keep them on schedule.
4. Hand out schedules and booklets to groups as they start out on the tour. Assign each group a different starting area so that there are not large groups overwhelming any of the buildings. Each student is to turn in three sketches.

Maxwell Museum of Anthropology

The purpose of this lesson is that students learn what went on inside the pueblo and cliff dwellings. This will help them to understand how structure serves function.

1. After their lunch break, students are to meet at the Maxwell Museum of Anthropology. Students are to be divided into groups of fifteen or less. Make prior arrangements with the museum to prepare the number of students you will be taking.
2. Students are to take the guided tour with groups starting at different areas so as to not congest any areas.

Closure

Closure of this lesson will be the next day after returning to school. Students will tack up their drawings for positive feedback from teacher and peers. For homework, students are to write an essay on what impressed them the most about the field trip. Upon returning to class, students are to share their essays with each other in groups of five or less and then turn them in to be graded.

Final Project -- Design And Build A Model Of An Energy- Efficient Southwestern Style Home

The purpose of this unit is for students to use prior knowledge to produce a meaningful project. Students will use what they have learned in this unit to design and build a model home of their dreams. The design will have a southwestern cultural style to it. Students will have to share ideas, concepts and cooperatively work with each other in groups of three.

Procedure

1. Divide class into groups of three. Allow students to choose their groups.
2. Students are to design and draft a home. They can model their home using viewed and posted pictures of the Pueblo and Spanish Colonial style examples. Also provide copies of a professionally drafted home and city building codes.
3. The order of progression will be as follows:
 - a. Design and draft home using 1/4 in. scale. Include at least one alternative energy source and a legend.
 - b. Draw elevations of the north, east, south and west sides.
 - c. Build a 1/4 in. scale model using materials that resemble chosen building materials.
 - d. Write an essay explaining your home and its design.
 - e. Class presentations of homes

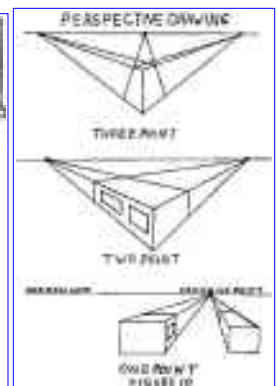
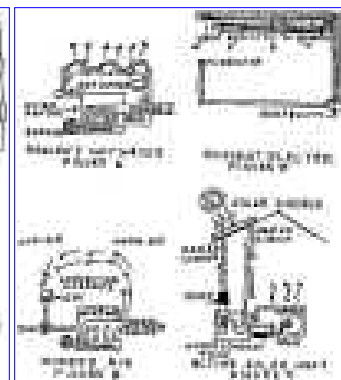
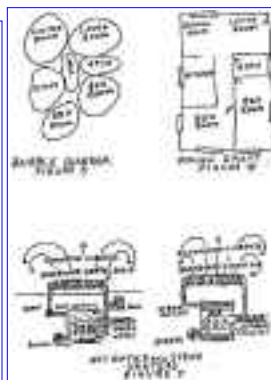
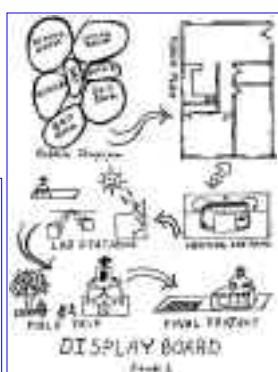
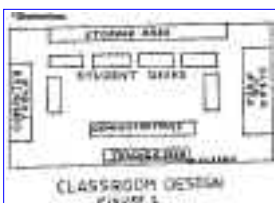


Figure 1

Figure 2

Figure 3-5

Figure 6-9

Figure 10

Figure 11

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