Build a HOME
Build a CAREER

SCIENCE

From the Ground Up: A Real-Life Lab

The Workforce Development Arm of the National Association of Home Builders
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Affiliated with
NAHB
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The Lesson Booklet series:

- **Career Exploration**
- **English/Communications**
- **Math**
- **Science**
- **Social Studies**

Lessons are built around steps in the HOME BUILDING PROCESS

PLANNING AND DESIGN PHASE

- Development/Construction Management
- Financial Management
- House Design
- Site Selection
- Determine Materials/Costs
- Zoning/Permits
- Site Preparation

CONSTRUCTION PHASE

- Purchase Materials
- Laying Foundation
- Framing
- Electrical/Plumbing/HVAC Installation
- Insulation
- Flooring
- Roofing
- Window Installation
- Drywalling/Finishing and Tapers
- Select plumbing, electrical, cabinet fixtures and floor coverings
- Finishing–carpentry, painting, tiling
- Flooring installation
- External finishing

THE HOME INTERIOR

- Smart House Enhancements
- Interior Design

LANDSCAPING

HOME BUYING

- Financing/Closing

HOME SELLING (ongoing throughout process)

- Public Relations/Advertising
- Marketing and Sales

SCIENCE

Table of Contents

Earth Science
Physics
Chemistry
Environmental Studies
Geography
Meteorology
Horticulture/Botany

SCIENCE

Introduction

The home building process can provide an effective, if unexpected, learning laboratory for your students. A well-built home is, in a sense, a successful science experiment.

Scientific principles are at work throughout the process – in the selection of the site and materials, the building design and construction, and even in the details: painting, landscaping and home automation enhancements.

These lesson ideas and activities are organized into three Units.

Unit 1: The Science of Building shows students how their science lessons apply to the construction of a home – from wiring and plumbing to HVAC.

Unit 2: All Through the House is a collection of lessons that illustrate how home building professionals rely on scientific principles and knowledge to design, build and decorate a home.

Unit 3: Landscaping: How Your Garden Grows highlights the science in our own backyards.

A few ideas:

- Conduct simple lab experiments/hands-on activities, or arrange visits to labs and companies where students can observe actual tests and procedures:
  - test the properties of different kinds of paints or visit a paint manufacturer
  - do in-class soil testing and screening, or arrange a trip to a nursery or local conservatory/ arboretum
  - work with an industrial arts class or local builder to involve students in constructing and wiring a mini-house
- Invite experts who can show students how they solve problems and achieve their objectives in building, landscaping, or interior design. Use the scientific principles your students are studying in class to explore the following careers:
  - architect
  - builder/developer
  - professionals in specific construction areas: carpenter, plumber, HVAC installer, etc.
  - landscape architects
  - painters
  - professionals who work with smart house enhancements

For additional activities that will engage your students, see the *Unit 1: Math in Construction* in the Math Lessons book and *The Design Process: Meeting Lifestyle Needs* lesson in the Social Studies Lessons book.

UNIT 1

The Science of Building

LESSON 1: Electricity: All Wired Up!

LESSON 2: Floor Systems: Building the Base

LESSON 3: Framing

LESSON 4: HVAC: Heat It Up! Cool It Down!

LESSON 5: Plumbing

Science comes alive in this science-focused lesson unit as students go on site visits and work with house plans to understand different housing components and systems. Individual lessons include Worksheets and Backgrounders that can be used for instruction, discussion and as the basis of in-class team quiz competitions.

For each of the lessons:

- Contact appropriate building professionals who can help lead discussions, demonstrations and house tours, and who can supply you with classroom resource and reference materials.
- Obtain at least five sets of house plans and materials take-off forms (see definition on page 7) from local building professionals that students will use throughout the unit in conjunction with on-site visits and classroom discussions and activities.
- Use the construction terms lists provided (starting on page 8) to build vocabulary booklets, and add to them as new words are introduced. Students should obtain definitions through research and interviews with building professionals.

Materials Take-Off Form

An essential for initiating any project is a list of all materials required to complete the job. The construction industry term for creating the list is to "prepare a take-off" of materials. The list itself is also referred to as the "take-off." It is crucial that the "take-off" information is accurate to ensure proper pricing for the project.

The top portion of the form includes the project name, location, bid date, and any names and phone numbers applicable to the project.

The form headings include as appropriate for the project: Quantity, model number, description, unit cost and total cost per item. All materials needed to complete the job are listed on the form in the appropriate sections.

Templates are included with each of the lessons in Unit 1.

Here are lessons in other Lesson Books that could provide blended instruction opportunities:

Math Lessons

Unit 1: Math in Construction

- Express Yourself Math Magically (Expressions)

- Picture This! (Formulas and Equations)

- To Scale (Ratio and Proportion)

- How Much Is It Worth? (Statistics and Central Tendency)

Social Studies Lessons

- Home, Home in the Ranch

- Who Built Our Town?

Construction Vocabulary 1

Basic Terms

- Anchor bolt
- Asphalt shingle
- Bottom chord
- Bottom plate
- Concrete (cement, water, and aggregate)
- Concrete block
- Corner post
- Cripple
- Double header
- Double top plate
- Fascia
- Felt paper
- Floor joist
- Footer
- Girder
- Gusset
- Jack stud
- Lintel
- Paint
- Plywood sheathing
- Post
- Rafter
- Rebar
- Ridgeboard
- Roof truss
- Roof types (gable, hip, shed, gambrel, and mansard)
- Rough sill
- Siding
- Sill plate
- Slab
- Stud
- Subfloor
- T- post
- Top chord
- Top plate
- Vapor barrier
- Web member
- Wire mesh

Construction Vocabulary 2

Tools and Materials

- 4-ft Level
- 120 and 240
- Air Handler
- Angle Drill
- Blower
- Breaker
- Chalk Box
- Circuit
- Condenser
- Copper Pipe
- Drill
- Duct Knife
- Evaporator
- Extension Chord
- Extension Ladder
- Fan
- Hammer
- Klines
- Metal Duct
- Outlet
- Panel Box
- Pressure
- PVC Pipe
- Reciprocating Saw
- Saw Bench
- Screwdriver
- Sledgehammer
- Speed Square
- Step Ladder
- Stove Pipe
- Striker

Construction Vocabulary 3

Sample Construction Professions

- Architect
- Brick Mason
- Building Inspector
- Cabinet Maker
- Concrete Mason
- Electrician
- Equipment Operator
- Framer
- General Contractor
- HVAC
- Interior Designer
- Landscape Architect
- Landscaper
- Painter
- Plumber

LESSON 1

Electricity: All Wired Up!

Students learn how electricity is conducted and controlled, discover the uses of electricity and explore how their lives would be different without it.

Preparation

Line up or prepare the following:

- Professional electrician
- Electrical Wiring Backgrounder and Worksheet
- At least five sets of house plans
- Five or more sets of Materials Take-Off Forms
- Trips to a site where students can observe electrical system installation

Procedure

- Introduce the topic of electrical wiring, using the Electrical Wiring Backgrounder and a professional electrician.
- Have students start by understanding the terminology and its application before completing the Electrical Wiring Worksheet.
- Plan a field trip to see wiring rough-in and trim-out.
- Interview an electrician.

Support Materials/Resources

- A professional Electrician
- Vocabulary lists
- Electrical Wiring Backgrounder and Worksheet
- House plans
- Materials Take-Off Form Template

Electrical Wiring Worksheet

1. Where is the electrical brain of a house?

2. Define ampere.

3. Define volt.

4. Define watt.

5. There are two different sizes of wiring circuits in a house. What are they?

6. The panel box is where individual circuits start and end. What device lets you turn them on or off and also protects against overloads?

7. Name the color and purpose of the three wires in 12-2 romex.

8. What is the purpose of electrical boxes?

9. What is used to fasten the romex wiring to the framing?

10. Name five tools used by electricians.

11. How many outlets can be in one circuit?

12. How many lights can be in one circuit?

13. A power company is responsible for delivering electrical service to your house. Where does its responsibility end?

14. What do the letters GFI stand for?

15. What is different about a GFI circuit?

Electrical Wiring Backgrounder

- Residential electricians set the meter can, breaker panel and all the individual circuits in the house.
- Major appliances such as water heaters, dryers, stoves, and air conditioners run on 240-volt circuits. Outlets and lights run on 120-volt circuits.
- The individual circuits are controlled at the panel box with circuit breakers.
- The most commonly used wire in residential wiring is romex. 12-2 with ground is the normal size wire used for lights and outlets. The black wire is called the hot wire. The white wire is called the common wire. The bare copper wire is the ground wire.
- All outlets near water (kitchen or bathroom) must be ground fault interrupter or GFI.
- Residential electricians must know what size wire to use to meet the local building codes.
- Electricians rough-in their wiring before the wallboard is up. After the walls are painted, they return and trim out or hook up all fixtures.

Materials Take-Off Form Template

Project Name: _____ Bid Date: _____

Location: _____

Name (of individual): _____

Phone: _____ Fax: _____ Email: _____

Quantity	Make/Model/Part No.	Description	Unit Cost	Total

LESSON 2

Floor Systems: Building the Base

Students learn about different flooring systems and what materials and tools are used for each system. They will work with the drafting class on the design.

Preparation

Line up or prepare the following:

- Building professional who can explain flooring systems.
- Floor System Worksheet.
- At least five sets of house plans.
- Five or more sets of Materials Take-off Forms.
- Trips to a site where students can observe different flooring systems.

Procedure

- Introduce the topic of floor systems. There are two types of floor systems: on-grade (concrete slab) and off-grade (concrete block and plywood). Develop a vocabulary list for this lesson.
- Have students form five groups so that each group will have a set of house plans as they complete the following tasks:
  - Work with drafting class to design five (5) sets of blueprints. Each base should have both types of floor systems designed.
  - Determine load capacities of each floor system.
  - Complete Materials Take-Off Form.

- Have students individually complete the Floor System Worksheet.
- Visit a house with each type of floor system.

Support Materials/Resources

- Vocabulary lists
- Floor System Worksheet
- Materials Take-Off Form Template
- House plans
- *Modern Carpentry*, Wagner and Smith, Copyright 1988.
- *Construction Technology*, Mark W. Huth

Floor System Worksheet

1. Estimate the amount of rebar needed for the house.
   Hint: (rebar comes in 20-ft lengths)

2. Estimate the amounts of wire mesh needed for the house.
   Hint: (wire mesh comes in rolls that cover 250 square feet)

3. Estimate the amount of vapor barrier needed for the house.
   Hint: (vapor barrier covers 500 square feet per roll)

4. Estimate the amount of concrete needed for the house.
   Hint: (a yard of concrete covers 81 square feet at 4-ft thick)

5. Estimate the amount of concrete block needed for the house. The house sits on a flat lot and the block wall needs to be 48 feet high.
   Hint: (concrete blocks are 16-ft long and 8-ft tall)

6. Estimate the amount of sill plate needed for the house.
   Hint: (sill plate covers the top of all concrete blocks)

7. Estimate the amount of 2x10 needed for the girders.
   Hint: (girders are tripled and placed every 12 feet)

8. Estimate the amount of 2x8 needed for the floor joist.
   Hint: (floor joists are placed across the girders every 16 inches)

9. Estimate the amount of plywood subfloor needed for the house.
   Hint: (plywood is 4 feet wide and 8 feet long)

10. Which floor system is more cost efficient?

Materials Take-Off Form Template

Project Name: _____ Bid Date: _____

Location: _____

Name (of individual): _____

Phone: _____ Fax: _____ Email: _____

Quantity	Make/Model/Part No.	Description	Unit Cost	Total

LESSON 3

Framing

Students learn about different materials used for wall framing:
- concrete block – exterior walls built by block masons;
- poured concrete – forms erected by carpenters, concrete poured by concrete masons;
- wood framing – erected by carpenters.

They will discover how physics is used in testing the strength and load capacity of materials to be used for framing (softwood, hardwood, block, logs).

Students will also learn about two methods of building a roof:
- purchasing roof trusses from a truss factory
- common framing (carpenters build the roof themselves).

Preparation

Line up or prepare the following:

- Carpenter, block mason, concrete mason
- Framing Backgrounder and Worksheet
- At least five sets of house plans
- Five or more sets of Materials Take-Off Forms
- Trips to a site where students can observe the framing process

Procedure

- Introduce the topic of building the superstructure of a home, using the Framing Backgrounder as a resource. Invite a builder to discuss the backgrounder with students and take them on a tour of a house site where they can see wall framing and a roof being built.

- Visit homes in which different materials (wood, block, concrete) were used in framing.
- Invite a panel of members from the local HBA representing block masons, carpenters, and concrete masons to discuss different materials and answer student questions.
- Define vocabulary words for the lesson; have students complete the Framing Worksheet or turn it into a competition/game. Set up several student teams and ask the questions on the Worksheet. You can even bring in simple buzzers or bells and instruct teams to signal if they know the answer.
- Have students form five groups. Give each group a set of house plans and ask them to complete the Materials Take-Off form for the superstructure.

Team Teaching/Blended Instruction Opportunities

Art/Art History, Consumer Economics, English, Industrial Arts.

Activity Extensions

- Help interested students line up volunteer positions at a historic site or local history/ethnic museum to gain greater awareness of the fields of study in historic preservation. Ask them to prepare short reports for the class on their experiences.
- Have students research the earliest construction processes by people in your area (Native American, early trappers or settlers) and compare those methods with housing construction now. What is similar? What early methods have been adapted and are still used? What changes have taken place? Why? Student teams can work with an industrial arts class to actually build a demo model of a local early dwelling to accompany reports.

Support Materials/Resources

- Building professionals
- Vocabulary lists
- Framing Backgrounder and Worksheet
- Materials Take-Off Form Template
- House plans
- *Modern Carpentry*, (Units 9, 10, 13) Wagner and Smith, Copyright 1988
- *Construction Technology*, Mark. W. Huth

Framing Worksheet

1. How many 2x6s are needed for the plates? Remember that 2x6s are used only on the exterior plates.

2. List the number and size of all exterior and interior doors.

3. How many 2x10s are needed for all exterior door headers?

4. List the number and size of all windows.

5. How many 2x10s are needed for all windows?

6. If you are framing with 2x4s, you will need a stud for every 12 feet of wall. How many studs are needed for the house?

7. If you are framing with 2x6s, you will need a stud for every 18 feet of exterior wall. How many studs are needed for the house?

8. How much plywood is needed to sheath the exterior of the house? Remember that plywood is four feet wide and to subtract the area of doors and windows.

9. How much plywood is needed to sheath the roof? Do not forget to allow for two feet of overhang on each end of the roof if it is a gable roof.

10. How many rolls of 15lb felt are needed for the roof if a roll covers 250 square feet?

11. How many rolls of 30lb felt are needed for the roof if a roll covers 125 square feet?

12. How many squares of asphalt shingles are needed for the roof if one square covers 100 square feet?

13. If a length of drip edge is 10 feet long, how many will it take for the roof?

14. If a length of ridge vent is four feet long, how many lengths will it take for the roof?

Framing Backgrounder

There are three ways to erect the superstructure:

1. concrete block
2. poured concrete
3. wood framing

There are two ways to frame a house – 2x6 exterior walls with studs, 24′ on center; or 2x4 exterior walls with studs, 16′ on center.

All exterior headers should be double 2x10s with one cripple under each side up to 6′ and two cripples under each side over 6′. For example, an 8′ garage door would need two 10′ long 2x10s because a double cripple is needed for each side.

Materials Take-Off Form Template

Project Name: _____ Bid Date: _____

Location: _____

Name (of individual): _____

Phone: _____ Fax: _____ Email: _____

Quantity	Make/Model/Part No.	Description	Unit Cost	Total

LESSON 4

HVAC: Heat It Up! Cool It Down!

Students learn the principles behind heating and cooling, and how HVAC is installed.

Preparation

Line up or prepare the following:

- HVAC professional
- HVAC Backgrounder and Worksheet
- At least five sets of house plans
- Five or more sets of Materials Take-Off Forms
- Trips to a site where students can observe HVAC installation

Procedure

- Discuss R values (insulation properties) and how insulation is used to retain both heat and coolness (depending on the season). Conduct demonstrations to illustrate the fact that warm air rises and cold air sinks.
- Introduce the topic of HVAC using the HVAC backgrounder.
- Discuss the need for central heat and air conditioning; how the need varies depending on geographical location; and how the development and use of HVAC systems have had an impact on society. For example, the calendar for the school year was originally set to start with the cooler months in the fall and to end before the heat of summer arrived.
- Discuss the importance of climate control (no bugs, no mildew, etc.).

- Tour a site to see an HVAC system installation.
- Have students work with house plans to identify HVAC.
- Use the worksheet as a quick quiz, asking questions out loud and calling on students for answers.

Support Materials/Resources

- Vocabulary lists
- HVAC professionals
- HVAC Backgrounder and Worksheet
- House plans
- A site to visit
- Materials Take-Off Form Template

HVAC Worksheet

1. What do the letters HVAC stand for?

2. Name the two basic components of an HVAC system.

3. What controls both components?

4. How is the conditioned air distributed through the house?

5. Ductwork should not be seen. So, where are the ducts placed?

6. What materials are used for ductwork?

7. What is used to push the conditioned air through the ductwork?

8. What gas is used in an HVAC system? Hint: The gas is harmful to the ozone layer.

9. The condenser in the outside unit resembles what part of an automobile?

10. What type of pipe is used to connect the inside and outside units? Hint: Same as plumbing supply pipe.

HVAC Backgrounder

There are two separate units to a basic HVAC system.

The outside unit, or condenser, disburses hot freon gas back to a cool liquid for cooling purposes.

The inside unit or air handler distributes hot or cold air through ductwork.

Heated air is produced in one of three ways:

1. electric heat strips
2. gas furnace
3. heat pump

The thermostat controls both units. The conditioned air is sent back to the air handler through the return duct. A filter catches dirt particles to keep the evaporator clean in the air handler.

Materials Take-Off Form Template

Project Name: _____ Bid Date: _____

Location: _____

Name (of individual): _____

Phone: _____ Fax: _____ Email: _____

Quantity	Make/Model/Part No.	Description	Unit Cost	Total

LESSON 5

Plumbing

Students apply physics to plumbing as they explore properties of gravity, pressurized systems, ventilation, and material capabilities, and trace the development of such systems from the Roman aqueducts.

Preparation

Line up or prepare the following:

- Plumbing professional
- Plumbing Backgrounder and Worksheet
- At least five sets of house plans
- Five or more sets of Materials Take-Off Forms
- Trips to a site where students can observe plumbing installation

Procedure

- Introduce the topic of plumbing using the Plumbing Backgrounder. Discuss how physics principles apply to plumbing systems.
- Have students define vocabulary words, then complete the Plumbing Worksheet.
- Discuss the history of plumbing, beginning with the ancient Romans' invention of aqueducts and continue through the advances from the outhouse to indoor plumbing. Discuss what scientific knowledge and technology breakthroughs made our modern plumbing possible.

- Discuss properties of gravity, pressurized systems, ventilation, and material capabilities, and how these factors help determine the design of a plumbing system.
- Have students form five groups so that each group has a set of house plans to complete a Materials Take-Off form.
- Take students on trips to see (1) rough in, (2) stack out, and (3) trim.
- Invite a plumber and well driller to speak to the class.
- Arrange a tour of the city's treatment facilities.

Support Materials/Resources

- Vocabulary lists
- Plumbing professional
- Plumbing Backgrounder and Worksheet
- Materials Take-Off Form Template
- House plans
- *Modern Carpentry*, Wagner and Smith, Copyright 1988
- *Construction Technology*, Mark W. Huth

Plumbing Worksheet

1. Name the two types of plumbing systems used in residential construction.

2. What material is used for supply pipe?

3. How are supply pipes joined?

4. How many fixtures are in the house? Hint: Any water-using device is a fixture.

5. Tubs or showers are either right- or left-handed, depending on which side the faucet is. How many tubs or showers are there and which hand are they?

6. Name five tools used by plumbers.

7. What material is used for drainage pipe?

8. How are drainage pipes joined?

9. What is the purpose of p-traps?

10. Why must drainage pipes be vented?

11. The three phases of plumbing a house are the rough-in, stack-out, and trim-out. Which of these would need to be completed before the slab can be poured?

12. Which phase is the final?

13. Estimate the amount of supply pipe needed for your house. Hint: All fixtures use hot and cold water except toilets and icemakers, so double your piping otherwise.

14. Estimate the amount of drainage pipe needed for your house. Hint: All drainage systems converge to a central homerun pipe to exit the house to the sewer or septic tank. Also, do not forget about the vent piping. Rule of thumb: one vent per bathroom or kitchen.

Plumbing Backgrounder

There are two plumbing systems in residential construction:

1. Supply brings fresh water to all fixtures (sinks, tubs, toilets, hose bibs, etc.).
2. Drainage or waste removes dirty water.

Supply is under pressure and drainage is not. Copper piping is used mostly for supply. Why?

PVC (poly-vinyl-chloride) is used mostly for drainage and venting. Why?

Materials Take-Off Form Template

Project Name: _____ Bid Date: _____

Location: _____

Name (of individual): _____

Phone: _____ Fax: _____ Email: _____

Quantity	Make/Model/Part No.	Description	Unit Cost	Total

UNIT 2

All Through the House

LESSON 6: The Right Stuff: The Nature of Building

LESSON 7: Build and Wire a Mini-house

LESSON 8: How Smart is Your Smart House?

LESSON 9: The Art and Science of Painting

This unit is a collection of individual lessons that showcase the role of different scientific disciplines in residential construction.

LESSON 6

The Right Stuff: The Nature of Building

Students explore the ways climate, geography and environmental factors and issues dictate building materials and construction methods. Students will learn to use critical thinking skills to understand how architects and builders make decisions about what can be built where.

Preparation

- Contact developers and builders to help you create several simple building scenarios in order to provide students with information on how geography, local climate and environmental considerations impact your area's building and development.
- Arrange a visit to different home sites (and homes in various stages of completion) to observe different choices in materials and construction methods.
- Research resources that students can use to examine and compare physical properties of building materials.

Procedure

- Tell students they are going to provide recommendations for the types of building materials to be used in the basic construction of a home. Discuss what factors architects and developers would consider from an external, environmental standpoint – the climate, environmental concerns, topographical/meteorological issues. (Are mudslides, floods, or earthquakes likely?)

- Divide students into "developer" groups of five or six. Give each group a building scenario that includes a sample home type and location. Work with a developer to come up with scenarios that pose different climatic and environmental challenges. (Example: a five-room, two-story home in the hills near Palo Alto, California.)
- Suggest resources students can use to research the subject and develop a plan. If possible, bring in several professional builders to guide students.
- Tell students that each team should be prepared to present recommendations on the materials to be used in their home based upon climate, topography of their lot, the type of house, and other considerations. Presentations should include written justification for their choices. To make presentations more interesting, encourage students to include pictures of the homes and locations.

Support Materials/Resources

- Local architects and developers
- Web sites, articles and books on various building materials and different climates

LESSON 7

Build and Wire a Mini-house

Incorporating real world experiences into the classroom helps students develop skills that will stay with them long after they leave school. Unfortunately, it is sometimes hard for students to believe that what they learn in the classroom will ever be useful to them in the real world.

Building a house is one experience that requires many different skills and involves several professions. This project-based lesson teaches basic electricity concepts as students build a small-scale model house with wiring for lights.

Note: See the Math Lessons in *Unit 1: Math in Construction* for activities that focus on the math skills and concepts involved in house construction.

Preparation

- Collect materials for the project. See House Materials list under Support Materials/ Resources.
- Enlist the assistance of students from a building construction/industrial arts class who can serve as "contractors" for your different builder groups.

Procedure

- Introduce the lesson with activities/demonstrations that help students learn to:
  - Identify the difference between series and parallel circuits
  - Calculate voltage, resistance, and power
  - Work word problems involving voltage, current, resistance, and power
- Divide students into small groups of two or three. Have them write a proposal and design a basic floor plan for a house or room they intend to build, working with a building construction class.
- Distribute supplies and let the students build the basic frame of the house. (This can take several class days.)
- Once students have built the house and are ready to add the electricity, instruct them to try hooking up the battery and lights several different ways. The objective is to figure out how to light as many lights as they can with one battery, and learn the difference between series and parallel circuits.
- Have the students present their projects to the rest of the class. They should be able to trace the path of electricity and tell whether they used series or parallel circuits. They also should report to the class the voltage, resistance, and power used in their circuits.
- Have the students determine what their electricity bills would be by calculating the power used in their houses.

Support Materials/Resources

Merrill Physics: Principles and Problems, Glencoe/McGraw-Hill, 1995, Chapters 20, 22, and 23.

House Materials

For a class of approximately 30 students, the following would be needed:

- approximately two sheets (4 ft x 8 ft) of quarter-inch plywood (or any other fairly thin wood; Balsa wood is ideal, but very expensive)
- eight 9V batteries
- several hinges
- a couple of simple motors
- six to eight switches
- electrical tape
- one string of Christmas lights (100 lights)
- small nails, hammer, screwdriver, additional tools as needed

Note: Ask a local home store or HBA members for donations or discounts. Most have budgeted a specific amount of money for donations. If you plan ahead and ask them early, they are very willing to help. Also, you probably want to involve a construction teacher or class to cut wood and help students use the tools. They can also provide information so you can avoid mistakes that will waste materials.

LESSON 8

How Smart is Your Smart House?

In this technology-based lesson, students will conduct internet research to learn about the different automated systems being built into homes, then use critical thinking skills to plan an automated home system that will meet different needs.

Preparation

- Research web sites about automation in homes, such as the smart house system.
- Find a local contractor who installs automated systems to provide information and a tour.

Procedure

- Introduce the topic of automation in housing. Ask students if they know what a smart house is. List some of their answers. Talk about the interrelationship of science, technology, and society. Provide information on smart houses or refer students to web sites where they can investigate the subject.
- Divide the class into small groups of two or three and assign each group a specific home automation system to research and report on. They may choose from one of the following: thermostats, intercom systems, motion sensors, electronic door locks, security systems, automatic sprinkler systems, programmable VCRs and stereo equipment, etc.
- Another way to group the students is by type of homeowner: a wealthy couple, a family with several small children, a family with a member who uses a wheelchair. Each of these would have different priorities when it comes to home automation. Tell students they should be prepared to present their conclusions to the class in an oral or visual form, as well as in written report form.

- Have groups pair up and compare/contrast their systems. Ask students to evaluate each other's projects and make suggestions for improvement. Give groups a day to make any changes before their presentations.
- Have students research the changes in home construction in the last century. They should focus on the "new," modern conveniences that were introduced in different periods.
- Students who have an interest in systems theory can explore how systems are used in other industries and compare/contrast those to the construction industry.
- Bring in a builder/developer who can share a case study of an automated house and even take students on a tour and demonstration.

Support Materials/Resources

- Local builder/contractor who installs automation systems in homes
- Access to computer lab
- http://intelligentstructures.com/home_auto.htm
- Additional web sites on home automation

LESSON 9

The Art and Science of Painting

Students examine the scientific and artistic aspects of paint and explore the history and composition of this group of liquid mediums used as a decorative or protective coating.

Preparation

- Identify resources for historical information about paint – i.e., paint companies such as Sherwin Williams, Diamond Vogel, etc., and web sites.
- Collect materials for in-class demonstrations/experiments: different kinds of paint (oil-based, water-based), paint brushes, rags, unpainted wood board.
- Contact a painter/interior designer who can explain the art and science of painting.

Procedure

- Ask students if they have ever painted a room or a wall, or some part of a home or building, or maybe watched someone paint. Discuss the knowledge a painter must have. Point out that a lot of the key information is really scientific in nature: the composition of the surface to be painted, how different paints work in varying conditions and on different surfaces as well as the environmental factors that will affect paint – temperature and humidity.
- Invite a painter to class to demonstrate or present the steps in painting and reinforce the basic science principles involved. If possible, provide paint, brushes and pieces of board (or ask the painter to bring some supplies) so students can participate. Hold a brainstorm session about the outcomes under different conditions.

- Ask student teams to research and develop a presentation on an aspect of paint and painting that interests them. The finished presentation could focus on: how, when and why paints were developed for home protection and decoration, how paint was used in a certain period of history (U.S. Colonial times), the components of quality paint (how is paint made), different types of paint (water-based, oil-based) and their uses, painting techniques used in decorating (ragging, washes, etc.). Tell students to be creative with their presentations and to include oral, written and visual components, such as a demonstration, a miniature room or a how-to poster combining words and illustration.

Activity Extensions

How much is enough?

The type of surface, as well as the type of paint determine the amount of paint you will need. Have students work in small groups to research the coverage of different types of paints under different conditions and on different surfaces (according to paint manufacturer specifications). Then ask them to create problems for the rest of the class to solve.

Example: A group shows the class a house diagram with five rooms; the room sizes and types are indicated. The group lists a high-gloss, semi-gloss and flat paint that will be used, along with information about each paint's coverage abilities. The group also provides information about the condition of the surfaces to be painted, which may be relevant to the solution. The class has to determine how much paint will be used in the house, based on which kind of paint will be used in which rooms and what kinds of coverage each paint provides. In addition to a numeric answer (5 gals of latex, 3 gals of gloss) students should explain their reasoning process.

When paint is not just paint.

Invite a painter/interior decorator/designer to demonstrate and discuss such painting techniques as masking, stenciling, sponge painting, rag painting and antiquing. You may want to use an art room, outside work area or artist's studio for this lesson. If possible, students should have a chance to try out some of the techniques and be able to discuss how science and art converge.

Learn from the Masters

Visit an art museum or present a video/slide show of artworks, focusing on a particular painting style or period.

Team Teaching/Blended Instruction Opportunities

Art, Art History, Graphic Arts, Pre-Architecture.

Support Materials/Resources

- Professional painter/interior decorator
- http://www.paint.orq/ind info/historv.htm
- *The Handbook of Painted Decoration: The Tools, Materials, and Step-by- Step Techniques of Trompe-L 'Oeil Painting*, Yannick Guegan an Roger LePuil
- *The Perfect Palette: Fifty Inspired Color Plans for Painting Every Room in Your Home*, Bonie Rosser Krims
- *Decorative Paint and Faux Finishes*, Linda J. Selden
- *Complete Paint and Wall Coverings*, Rob Lutes

UNIT 3

Landscaping: How Your Garden Grows

These lessons provide different approaches you can use to integrate landscaping into earth science, horticulture and even computer technology lessons.

LESSON 10

Begin with Basics: Test the Soil

Students learn that soil, the foundation of landscaping/gardening, is a living medium as they test and screen soil in their community.

Preparation

Order labs for soil testing and screening.

Note: If it is not possible to conduct soil testing, arrange a class at a soil testing facility or local botanical garden so students can observe the process.

Procedure

- Facilitate a discussion focusing on the fact that the soil is a living web of life that covers the planet and enables our existence. Talk about what the class can learn by testing the soil: What is the soil composed of? What types of organisms are living in the soil? What kinds of plants, flowers, crops are best suited to the soil?
- Demonstrate correct use of lab equipment and the collection methods for soil types.

FOR SOIL TESTING AND SCREENING

- Prepare soil lab set-ups; soil-testing labs
- Nutrients and minerals lab
- Water content and composition lab
- Soil pH kit
- Microbe isolation and growth kit
- Soil screens and filters

- Show a video, such as "The Science of Soil," before the lab is completed. Show a geology video, such as "Rocking World of Geology," at the end of the lab sequence.
- Ask students to suggest ways to implement good soil conservation techniques. Bring in professionals to address the subject.
- Soil screening is fun and should be done on a lab team basis. Choose a site. Stake out a one-square-foot area at the chosen site and then dig one foot in to obtain a one-cubic-foot soil sample. (You may want to ask students what they need to do in order to end up with a one-cubic-foot soil sample). In the lab, divide the sample into five or eight equal portions. Tell each lab team to screen and filter out every insect using tweezers and collection jars. They can then quantify the insect life found in the sample.

Support Materials/Resources

- Lab supplies from: www.hubbardscientific.com
- "The Science of Soil" by Videos for the Classroom
- "Rocking World of Geology" by Standard Deviants
  Available from: Teachers Video Company; 1-800-262-8837

LESSON 11

Learn to Xeriscape™

Students are introduced to the concept of Xeriscaping™ (water – efficient landscaping) and the importance of this environmentally friendly method to the building industry.

Preparation

- Develop a list of plants adapted to the area.
- Contact local developers/landscapers who are familiar with Xeriscaping to be lesson resources.
- Locate web sites and books about Xeriscaping for your area of the country.
- Interview landscape maintenance professionals to learn their views on landscaping to save water.

Procedure

Introduction to Xeriscaping

- Lead a discussion about the importance of preserving natural resources and the role of Xeriscaping in accomplishing this task.
- Assign groups to research the history of Xeriscaping (a trademark of Denver Water) using the internet and printed resources, and to find examples of the ways it is being used around the country.
- Ask students to identify low maintenance landscaping materials and plants adapted to their area using the internet, local nurseries and landscapers. You may want to assign groups to research a type of plant, such as groundcover or flowering perennials. Individuals within the group can research different kinds of plants within their assigned type.

Xeriscape is a registered trademark of Denver Water, Denver, CO and is used here with permission.

Grow a Xeriscape Garden

- Assign teams of two or three students to come up with a design or method (hypothesis) that will help the community save water, e.g., landscaping changes that could be implemented.
- Take students on a walk around the school grounds with analysis in mind. Ask them to take notes of their observations.
- Bring in a speaker or visit a local facility and talk with someone who can address the Xeriscaping method and explain the goal: to use plants to improve property without being a drain on the local water budget or environment. Ask students to make notes on plant types and maintenance required.
- Have students design and build their Xeriscape concepts in model form or in terrariums. Remind them to focus on the use of adapted plants.
- If possible, create and maintain a Xeriscape habitat in a controlled area on school property. This activity can be a joint venture with other classes. Be sure to get a commitment from students or faculty, or even school maintenance staff, to care for the garden over the summer, at least during the first couple years of establishment. There also are mini-grants that can be obtained through the tech support department on campus.

Support Materials/Resources

- Local plant societies, nature preserves, public gardens
- 3-D Garden Composer software
- Local landscape architects and water management district representatives
- Xeriscape web sites from different areas
- Xeriscape gardening guides designed for your area
- xeriscape.org
- County Cooperative Extension Agents

LESSON 12

Create a Virtual Garden: Working with CAD

This lesson combines computer technology with earth science/horticulture to provide students with the hands-on experience of creating landscaping.

Preparation

- Obtain landscaping software and familiarize yourself with the program.
- Contact landscaping professionals, and experienced local gardeners who can serve as student advisers in developing a garden plan. (The advisers don't have to be familiar with landscaping software.)
- Collect house and garden magazines that students can use as reference.

Note: This lesson can be conducted in conjunction with other science classes, computer technology classes or industrial arts classes.

Procedure

- Introduce the class to the landscape software (Computer Assisted Design [CAD]) and assign the design project.
- Before they begin creating a virtual garden, have them research ideas by looking through magazines and touring local gardens.
- Ask experienced local gardeners to give students a tour of their gardens, explaining how they planned the garden and how they maintain it.
- Students can visit local nurseries/garden centers or local public gardens for additional ideas about plants and designs.

- Give students definite guides for creating their garden. You may want to select a home style on the program ahead of time. Tell them to consider plants that are suitable to your climate and soil type; to create a garden that will look good throughout the year; and to determine how they will maintain the garden, and protect plants from pests.
- Invite a landscaping design professional to evaluate student CAD designs.

Support Materials/Resources

- Landscaping Your Home: Creative Ideas from America's Best Gardeners (Fine Gardening Design Guides) – or other slide presentation on landscaping
- 3D Garden Compose (approximately $30) or some other comparable landscaping software
- http://www.gardencomposer.com
- Personal computers
- Local landscaping/nursery/garden center professional to advise

Content Standards

Science

Students will:

- Apply the use of technology to complete a task.
- Organize and maintain information.
- See things in the true mind's eye.
- Use basic reading, writing, and math skills to facilitate the completion of a technological task.
- Understand that all matter has observable, measurable properties.
- Understand that the types of force that act on an object and the effect of that force can be described, measured, and predicted.
- Use the scientific processes and habits of mind to solve problems.
- Understand that science, technology, and society are interwoven and interdependent.
- Understand how knowledge of energy is fundamental to all the scientific disciplines (e.g., the energy required for biological processes in living organisms and the energy required for the building, erosion, and rebuilding of the Earth).
- Know that changes in a component of an ecosystem will have unpredictable effects on the entire system, but that the components of the system tend to react in a way that will restore the ecosystem to its original condition.
- Know that the world ecosystems are shaped by physical factors that limit their productivity.
- Know that investigations are conducted to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.

- Understand that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories, new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth.
- Know that scientists can bring information, insights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.

Technology

Students will:

- Apply the use of technology to complete a task.
- Organize and maintain information.
- See things in the true mind's eye.
- Use basic reading, writing, and math skills to facilitate the completion of a technological task.

Mathematics

Students will:

- Understand the different ways numbers are represented and used in the real world.
- Understand number systems.
- Understand the effects of operations on numbers and the relationships among these operations; select appropriate operations, and compute for problem solving.
- Use estimation in problem solving and computation.
- Measure quantities in the real world and use the measures to solve problems.
- Compare, contrast, and convert within systems of measurement.
- Estimate measurements in real-world problem situations.
- Select and use appropriate units and instruments for measurement to achieve the degree of precision and accuracy required in real-world situations.

Language Arts

Students will:

- Apply a variety of response strategies, including rereading, note taking, summarizing, outlining, writing a formal report, and relating what is read to their own experiences and feelings.
- Locate, gather, analyze, and evaluate written information for a variety of purposes, including research projects, real-world tasks, and self-improvement.
- Synthesize information from multiple sources to draw conclusions.
- Write text, notes, outlines, comments, and observations that demonstrate comprehension and synthesis of content, processes, and experiences from a variety of media.
- Organize information using appropriate systems.
- Select and use a variety of electronic media (such as the internet, information services, and desktop publishing software programs) to create, revise, retrieve, and verify information.

Process/SCANS/NCDS

- Acquire information from a variety of resources.
- Use information that has been verified in drawing conclusions, make predictions, and determine cause and effect.
- Acquire information through the use of technology and communicate basic understanding of scientific principles effectively both orally and in writing.
- Work responsibly in teams.
- Use resources appropriately.
- Apply basic skills effectively.
- Acquire information from a variety of resources.

Home Building Industry Careers

The Department of Labor has identified more than 100 occupations and careers associated with the residential construction industry, in eight major categories.

Here are just a few that might be of particular interest to students who enjoy science:

PRECISION, PRODUCTION, CRAFT & REPAIR

- Carpenters
- Electricians
- Plumbers
- Painters

PROFESSIONAL SPECIALTY

- Engineers: Civil, Electrical, Electronic, Industrial, Mechanical, Safety
- Architects/Landscape Surveyors
- Systems Analysts & Data Base Administrators
- Regional & Urban Planners

TECHNICIANS & RELATED SUPPORT

- Engineering Technicians
- Drafters
- Computer Programmers

OPERATORS, FABRICATORS & LABORERS

- Operating Engineers
- Gardeners & Groundskeepers

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