Energy Academy Lesson plans
Grades 9-12

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“Energy Considerations In Basic House Design”
Energy Considerations in Basic House Design

I currently teach a high school introduction to construction class in which the students study many aspects of designing and building a residential structure. Some of the topics we study include materials, methods, tools, site considerations etc. This class uses a project-based format where the students ultimately design a house and prepare a set of plans for it. When possible the class also constructs actual building projects as opportunities present themselves. We usually briefly discuss the mechanical systems of structures but I believe that with increasing concerns of rising energy costs, availability, environmental issues etc. that the energy needs and usage of a structure should be focused on in more depth as part of this course. These energy lessons will be introduced in the course after the students have prepared preliminary floor plans using 3-D Home Architect and Auto Cad software.

Overall Objective of activities 1-5: To analyze the energy requirements of a residential structure and incorporate and include alternative energy sources into the design blueprints to supply as much of the energy as possible.

I find that most of the students that I generally have in this course have a relatively shallow understanding of energy, how it is generated, and basic energy principles. I think it would be important to begin this unit with a general discussion of the history of human population and energy use. The fact that many traditional forms of energy,(wood, coal, gasoline etc) ultimately are forms of solar energy. Also understanding the change in human energy consumption after the industrial revolution to unsustainable levels and the challenges that this creates for us as we plan our future.
Day 1  Activity #1  Time Frame: 1 period

Activity Objective: Students will identify specific devices and the major mechanical systems in a residence that require energy: (i.e. climate control/water supply/cooking/clothes care/lights/entertainment etc.)

Activity: In groups of 3 or 4 students will brainstorm and develop a list of all the devices in a house that require energy. They will then collaboratively decide how they think all of these items could be grouped into 4 or more categories. Each group will prepare and present their list and grouping strategy to the class through the use of the notability app on their i-pads projected onto the front screen. Following these presentations we will compare their results with the DOE pie chart shown below.

DOE. 2008 Buildings Energy Data Book section 2.1.5
STEM elements used:
#9 collaboration
#10 critical thinking
#12 communication
#15 constructing explanations and designing solutions
#8 use of technology and software

State TE. Standards used:
TE. HS.14 2006- appropriately operate technological devices and systems
As an introduction to the second activity we will discuss the fact that many of the devices that they categorized in the previous activity can be powered by different energy sources, (ie. You can have electric or gas water heaters, electric, gas, or wood furnaces etc.) Part of this discussion will also review what natural gas is and how electrical power is generated.

Day 2   Activity #2   time frame-1period

Activity objective: Students will determine how energy requirements for various devices are determined and rated.

Activity: Each group of students will select 1 device from each of their categories from the previous activity and research the devices via internet etc. to determine:

1- if the device is powered by electric or gas or either
2- what the energy requirements for the device is

Their results will be presented to the class by preparing it on their i-pads and projecting on the front screen. As a result of their research we should discover that electrical devices are usually rated by kilowatt hour and gas devices are rated by BTU’s/hr. We will discuss that comparisons between gas and electric devices can be achieved by the following conversion values:

1 BTU = .293 Watt hours    3413 BTU = 1 Kilowatt hour

As homework for this unit each student will compile a list of all the appliances in their kitchen at home and check the manufacturers tag on each one for watt ratings
STEM elements used:
#5 obtaining and evaluating information
#13 using mathematics and computational thinking
#14 analyzing and interpreting data
#4 community connections

State TE. Standards used:
TE. HS. 1 2006-Define how technology helps improve, manage, and control the natural and human-made environments
As an introduction to the 3rd activity we will review the pie chart above that we used in activity 1. This shows that climate control is the largest component of residential energy usage and thus perhaps represents the greatest potential for energy savings.

**Day 3  Activity #3.  Time Frame: 2 periods**

**Activity Objective:** Students will use critical thinking to research and select a climate control system to be used in a residential structure.

**Activity:** In groups of 3 or 4, students will use the internet to come up with 4 specific ways to heat or cool the interior of a residential structure. They will prepare a poster using the keynote app on their i-pads that includes pictures and brief explanations of operation of the 4 climate control devices they selected. Each group will present their poster on the front screen. As part of their presentation the group will also choose the device that they think represents the best choice and give reasons why.
Following their presentations we will discuss differences in their opinions of which device is best. We will also correct or add any information needed to clarify how the different systems operate. I do want to make sure all of the following systems are discussed:
  electric heat pump, electric forced air, electric baseboard, natural gas, wood furnace, and hot water,

  Each student in the groups will then be asked to select a climate control system that they would like to use in their individual house design. They will then use the square footage of the individual floor plan that they had created earlier in the course to determine the BTU’s required to heat their house and be asked to determine what the monthly and annual cost would be for the system they chose.

  What questions will they have? .... What month? Doesn’t it depend on the temperature how often furnace runs? Etc. Students should do some problem solving to figure out what data they should research (average temperatures etc.) to use to come up with average monthly and annual heating costs. As a class we will then compare the findings and compare the cost differences of the different systems

**STEM elements used:**
#3 asking questions and defining problems
#6 planning and carrying out investigations
#11 creativity
#16 engaging in argument from evidence

**State TE. Standards used:**
**TE. HS. 10 2006**-Specify solutions to stated needs and opportunities using appropriate technical means.
**TE. HS. 16 2006**-Select the appropriate devices and systems to meet personal and societal needs.
The final activity in this energy unit involves the integration of alternative sources of energy and energy conservation into the equation. I will introduce this lesson with a discussion of sources of alternative energy, asking the class what they know about kinds of alternative energy. I will focus the discussion on wind and solar sources. We will also discuss passive measures that can be integrated into basic house design to take advantage of solar energy such as maximizing natural light and the placement and orientation of windows for passive solar heat gain. Proper insulation is an important part of heat energy conservation and we will also discuss the various options available. We will also look at current residential wind generators available.

**Day 5 activity #4     Timeframe: approx 4 periods**

**Activity objective:** students will be able to integrate alternative energy sources into a house design

**Activity #5.** Following the discussion each student will be tasked to carefully evaluate their floorplan and blueprints. They will then make modifications that will maximize energy conservation, maximize passive solar gains, and include alternative energy sources of wind, solar panels, or both that will supply at least half of the climate control energy needs that they had previously determined for their house design. They will figure the cost of the alternative energy devices and how long it will take for the additional cost to pay out. Each student will create and present a keynote presentation that shows their original plans, the modified plans, and includes the data they used to determine the size of the alternative energy devices they added and how these will be integrated into the structure. They will also present the cost breakdown of the additional devices.
**STEM elements used:**
#2 project based learning  
#13 using mathematics and computational thinking  
#12 communication  
#15 constructing explanations and designing solutions

**State TE. Standards used:**
**TE. HS. 1 2006**-Define how technology helps improve, manage, and control the natural and human made environment.  
**TE. HS. 3 2006**-Understand the integrated relationship of technology with other academic fields, particularly language arts, math, science, and social studies

**Assessment:** Students will be given a quiz covering the main concepts covered in these discussions and 4 activities. This quiz will be given while the students are in the process of making changes to their house plans before they make their final presentations. The primary assessment of this class is the final set of blueprints and 3-d computer models of the house that the students create. The Energy components will be part of those final documents.

**Implementation plan:** These 5 energy activities will be inserted to the overall course after the preliminary floorplans are completed. At this stage changes can be easily made without much wasted time. These activities primarily utilize technology (Computer Drafting software, i-pads, internet etc.) and really does not require additional supplies.