Unit 7.3 Building Materials:
How we use our Natural Resources

Unit Overview

Location in Mi-STAR Curriculum

Unit 7.3: The 3rd unit in the 7th Grade Mi-STAR Integrated STEM Curriculum.

Unit Summary

Our continually growing human population depends on natural resources created through earth processes. All of the useful products we use in our daily lives are made from limited non-renewable resources (e.g. minerals) and renewable resources (e.g. fish and trees) that require sustainable management to ensure their availability for future generations. Each of these products impacts earth systems throughout its 'lifetime' - that is the acquisition of the resources, production of the product, use and disposal. In order to ensure a bright future for Michigan, we must make sustainable decisions when purchasing new products or developing new technology. The application of science and engineering practices in decision making is needed to ensure resource conservations and reduce the impact on earth systems.

In this unit we will consider the products and material we use to construct our communities' buildings. We encounter buildings everywhere, yet we do not often consider how the materials that buildings are made of impacts our lives. Students will be challenged to use science and engineering practices to select the 'best' insulation material for a new building in their community. To complete the unit challenge students will model a lifecycle of one building material by using core ideas from several different disciplines.

Geologic and earth processes occur on a variety of timescales and have operated over vast periods of time, resulting in the uneven distribution of mineral, energy, and groundwater resources (ESS 3-1). Many of these resources are nonrenewable, but are very important for the health and prosperity of human populations (ESS 3-4). For example, the availability of natural resources impacts the production of synthetic materials that we rely on to effectively insulate our homes (PS 1-3). Due to the limited availability of some of these resources, conservation and/or more efficient use are key components of natural resource management. In this Unit, students use science and engineering practices to determine the “best” insulation material given certain criteria and constraints that must be considered. Students explore how new technologies and designs can make buildings more thermally efficient and allow us to better manage natural resources. (PS 3-3).

Unit Big Idea:

- We can use science and engineering to choose building materials that perform well yet also conserve natural resources and reduce impacts on earth systems.

Unit Question:

- How can growing societies reduce impacts on earth systems and conserve natural resources through their choice of building materials?

Unit Challenge:

Unit Challenge Summary:

Students use a variety of science and engineering practices to apply their understanding of disciplinary core ideas towards the development of a model of the life cycle of an insulation material. Students identify and rank criteria regarding insulation materials in a decision matrix in order to choose the “best” wall insulation material for a new community building. The “best” insulation material will be that which maximizes the conservation of natural resources and minimizes the impact on earth systems while serving their desired function--to effectively insulate the building. Students compile new knowledge and evidence throughout the unit into a Unit Summary Table that will help students with the culminating activity. The final model of the insulation material’s life cycle will be used as evidence along with the decision matrix and summary table for the final recommendation of the “best” materials as outlined in the Unit Challenge Scenario.

Unit Challenge Scenario: [for presentation to students]

Students are presented with a scenario in which their local mayor is competing for an environmental sustainability award that, if won, could bring much-needed tourist dollars, federal grant money, and good publicity for your community. The city council has decided to build a community center that will provide new programs for the local population. In order to improve the mayor's possibility of winning, (s)he has commissioned several engineering firms (small student groups) to test individual insulation materials for the walls of the building that balance energy efficiency with the environmental impact of the specific insulation material. Each group (engineering firm) will use knowledge obtained in lessons throughout the unit to measure and rank certain characteristics (criteria) of their material using a provided decision matrix tool. The decision matrix will help the firms determine which insulation materials score better than others and will help groups arrive at a decision for a final recommendation based on the gathered evidence. At the end of the unit, all groups will come together to share their results and decide which material would be best to use for the community building and give the project the best chance of winning the environmental award.

Unit Challenge Exemplary Student Products:

1. A model of the Life Cycle of a Insulation Material
    a. Exemplar Student Product Draft
        i. Draft Overview of the model to give students an idea of the key stages of the Life Cycle. Teachers can present this to students as a template to keep in mind during the development of their final product.
        ii. Summary of information learned about each Lifecycle Stage - note: currently this is a graphic organizer that is not filled in. For each key idea in the model template above, students will complete each page of this graphic organizer to supplement the key idea of each phase of the model. The Unit 7.3 2016 unit writing team would be expected to complete a draft of this to be included as an answer key for implementing teachers.
        iii. Example Draft Rubric for Model

    b. Example Student Products from Pilot Testing
        i. Cellulose 1, Cellulose 2
        ii. Rockwool
        iii. Working on final product

2. A Unit Summary Table
    a. 7.3 Unit Summary Table- Note: this is only partially created to demonstrate how the information in the exemplary lesson would be included on the summary table. The 7.3 2016 summer writing team will complete this document for pilot teachers.

3. A completed Decision Matrix- with evidence-based reasoning provided for each criteria rating.
    a. Sample Completed Classroom Decision Matrix from piloting - Note: this document was developed during pilot testing. There is a recommendation for the 2016 7.3 unit writing team to modify this document to include a column for students to justify the rankings given. A short introductory video on Decision Matrices is located here.

List of Unit Challenge Student Products:

- Link to Unit 7.3 Unit Challenge product list (not active)

Gotta Have Checklist:

- Link to 7.3 unit-level Gotta Have Checklist - will be written during lesson development.
- Example Lesson 5 Gotta Have Checklist
    - How are the properties of the reactant(s) similar or different than the product(s)?
    - How and why did the reactants change during the reaction?
    - How can a synthetic material (product) be made from natural resources (reactants)?
    - How do some synthetic materials have an altered structure with enhanced properties that make them more useful to humans?

NGSS Connections:

Semester Unifying Crosscutting Concept: **Energy & Matter**

Primary Performance Expectations

- **MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.** [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).

- **MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [*Assessment Boundary: Assessment is limited to qualitative information.*]

- **MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*** [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]

- **MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.** [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

Primary Subcomponents

SEP: Science & Engineering Practices

- **Obtaining, Evaluating and Communicating Information:** Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)
- **Engaging in Argument from Evidence:** Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)
- **Constructing Explanations and Designing Solutions:** Constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
- **Constructing Explanations and Designing Solutions:** Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1 &)

DCI: Disciplinary Core Ideas

- **PS3.A: Definitions of Energy:** Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.
- **PS3.B: Conservation of Energy and Energy Transfer:** Energy is spontaneously transferred out of hotter regions or objects and into colder ones.
- **PS1.A: Structure and Properties of Matter:** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3)
- **PS1.B: Chemical Reactions:** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3)
- **ESS3.A: Natural Resources:** Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)

- **ESS3.C: Human impact on Earth's systems:** Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-4)

CCC: Crosscutting Concepts

- **Energy and Matter:** The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)
- **Cause and Effect:** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4 & MS-ESS3-1)
- **Structure and Function:** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)
- **NOS: Science Address Questions About the Natural and Material World:** Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)
- **STS: Influence of Science, Engineering, and Technology on Society and the Natural World:** The uses of technology and limitations on their use are driven by individual or societal needs, desires and values; by the finding of scientific research; and difference in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)
- **STS: Interdependence of Science, Engineering, and Technology:** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)
- **STS: Influence of Science, Engineering and Technology on Society and the Natural World:** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
  (ESS3-4 & MS-ESS3-1)

Supporting Subcomponents

SEP: Science & Engineering Practices

- **Constructing Explanations and Designing Solutions:** Apply scientific ideas or principles to design, construct and test a design of an object, tool, process, or system. (MS-PS3-3)

DCI: Disciplinary Core Ideas

- **ETS1.A: Defining and Delimiting an Engineering Problem:** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (MS-PS3-3)
- **ETS1.B: Developing Possible Solutions:** A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (MS-PS3-3)

CCC: Crosscutting Concepts

- **Energy and Matter:** Matter is conserved because atoms are conserved in physical and chemical processes.
- **Patterns:** Patterns can be used to identify cause and effect relationships.
- **Patterns:** Graphs, charts, and images can be used to identify patterns in data.