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The E in STEM: Meaningful Content for Engineering

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### Major Project: Engineering Design Challenge

#### **1. Identify the “Big” concept to be covered by the engineering design challenge.**

I chose the lesson “Feel the Heat”([https://www.nasa.gov/pdf/417998main\\_OTM\\_Feel\\_Heat.pdf](https://www.nasa.gov/pdf/417998main_OTM_Feel_Heat.pdf)) This lesson targets Utah 6<sup>th</sup> grade science standards (see number 2 below). The big idea is to use the engineering design process to measure how much heat is transferred in a solar water heater design. Also, to test the water heater and improve upon its design.

#### **2. Research appropriate learning standards associated with the topic.**

*Utah 6<sup>th</sup> Grade Science 6.2.4 standard:*

Design an object, tool, or process that minimizes or maximizes heat transfer. (PS3.A, PS3.B, ETS1.A, ETS1.B, ETS1.C)

*NGSS standard:*

MS-PS1-6 Undertake a design project to construct, test and modify a device that either releases or absorbs thermal energy by chemical processes\*.

#### **3. Identify and discuss the different types of problem solving and declarative/procedure knowledge needed.**

According to Jonassen (2000), a problem has two parts. First, a problem has an “unknown entity in some situation.” Second, solving the problem should contain a benefit to society (Jonassen, 2000). Problem solving also includes “any goal-directed sequence of cognitive operations” (Jonassen, 2000). This means a problem contains a mental representation and an activity-based manipulation. The Engineering design that I chose includes most the attributes Jonassen describes in his article.

For example, students simulate a real-life design that future robots or astronauts could use to survive on Mars (benefit to society). Another quality this activity contains is the activity-based experience (use materials such as tubes, cardboard, etc, to build the design).

A few declarative knowledge attributes needed for this lesson include:

- know that light produces heat
- know how to use a thermometer

A few procedural knowledge attributes needed for this lesson includes:

- understand how to build a solar power water heater
- understand how to test, evaluate, revise and improve engineering designs

#### **4. Explore objectives and ancillary concepts/content covered by the project.**

*The objectives:*

- Students will be able to understand how astronauts on the moon use solar energy for heat.
- Students will be able to explain conduction, convection and radiation.
- Students will be able to determine which features are needed for a successful solar water heater.
- Students will be able to understand that engineering designs usually don't work the first time. They require many tests, evaluations and redesigns.

#### **5. Identify possible activities.**

After reviewing the engineering design project, some activities include: building a solar power oven to roast “marshmallows for the astronauts.” Another possible activity for students is to connect individual water heaters together to observe if heat is lost faster. Students could also “concentrate the light” using aluminum foil and file folders to focus light on a local point in the water to observe if heat is gained faster.

#### **6. Select the best activity for your classroom.**

I think the best activity is to start with the original design which is to build a solar water heater. I think I would like to start with this activity because this is the first time for me to teach this design and I feel the directions for this particular lesson are more clear than the other activities. My students enjoy hands-on activities. I am looking forward implementing this idea to help my students understand the engineering process: brainstorm, design/build, test, evaluate and redesign.