The Light is Just Around The Corner
Written by: Maria Eby
7-6-2016

Description
This lesson plan will provide an opportunity for students to apply what they have learned about 3-D shapes, how light travels and earth conservation to create an energy saving structure.

Packet Contents

Lesson Plan Tags
Check the standards that are met in your lesson plan, check all that apply.
Mi☐dle School ☐ *6th Grade Science* ☐ *8th Grade Science* *Middle School Math*
Middle School CTE

Introduction
"Electricity generation is one of the leading sources of greenhouse gas emissions in the United States. Power plants that burn fossil fuels or materials made from fossil fuels, is the source of about 40% of total U.S. carbon dioxide emissions. Students will use math and science develop a structure that will reduce use of electricity in school buildings to reduce our carbon footprint." (Retreived from: http://www.eia.gov/energyexplained/?page=electricity_environment)

Curriculum Alignment
Math

6.G.4	Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

MP. 1	Make sense of problems and persevere in solving them

Science

6.P. 1	Understand the properties of waves and the wavelike property of energy in earthquakes, light and sound waves.

CTE: ER20.02 Discuss major sources of energy and ways to conserve energy

Objectives

- Students will be able to create a net for a rectangular prism
- Students will be able to construct rectangular prisms from nets
- Students will be able to have light travel around corners

- **Time & Location**
  This lesson can be conducted in your classroom. It will take a minimum of three 90 minute periods.

Teacher Materials

- Rubric
- Engineering Design Process Diagram
- Engineering Design Process Template
- Projector and speakers to show video clips
  Marshmallow Challenge :https://youtu.be/RtQr9w2pL74
  Environmental Impact: 4https://youtu.be/Ujm7l3h-CKk

Critical Vocabulary

- Rectangular prism: A solid (3-dimensional object) which has six faces that are rectangles
- Net: An arrangement of two-dimensional figures that can be folded to form a polyhedron (3-D figure); what you get if you "unfold" a shape
- Global Warming: a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, chlorofluorocarbons, and other pollutants.
- Fossil Fuels: a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms.

Student Materials

*Pleases note: this lesson is one of creativity and innovation. A large collection of donated items, such as empty boxes, empty water bottles and milk containers, any type of cardboard, etc. will be useful. The larger the choices of materials the more creative the students can be.

- Flashlights (1 per team)

- Yardsticks or tape measures (1 per team)
- Building materials (can be an assortment of items, such as, plastic, cardboard, foam board, etc.)
- Hot glue guns (1 per team)
- Packing or duct tape (3-4 rolls)
- Scissors (2 per team)
- Raw spaghetti (12 pieces per team)
- Yarn (one skein)
- Masking Tape (1 roll)

Safety

Students will be using the sharp point of scissors to puncture the tissue box to remove the top. Remind students to keep their hands out of the box while they are doing this.

Students may be using hot glue guns. They should be reminded not to let the glue touch their skin and/or clothing. There should be established "safe" areas to use the hot glue guns, as well as have a safe resting place for the gun when not in use.

Student Prior Knowledge

- The properties of a rectangular prism
- How to draw a net for a rectangular prism
- How to draw to scale
- How light travels, reflects
- Corners form 90 degree angles
- Global warming is considered a threat to earth
- Fossil fuels are non-renewable and are used for electricity

Teacher Preparations

- Cut the string into roughly 12 inch sections
- Each team needs 1 **yard** of **tape**, 1 **foot** of **string**, 20 pieces of spaghetti (uncooked, of course), and one marshmallow
- Prepare an anchor chart outlining the Engineering Design Process
- Prepare an anchor chart which includes the driving question and constraint of the project
  Driving Question: **How can we, as engineers, design a 3-D structure constructed of rectangular prisms, built from nets, that allow light to travel around corners?**
  As well as the following constraints.

  Constraints:

  1. Structure must be composed of rectangular prisms
  2. Structure must include at least 3 corners (90 degree turns)
  3. Light must light each section of the structure from one source placed at the front of the structure
  4. Structure must be free standing

- Copy engineering design process templates (one per team)
- Copy rubrics (one for each team)

Activities

Day One:

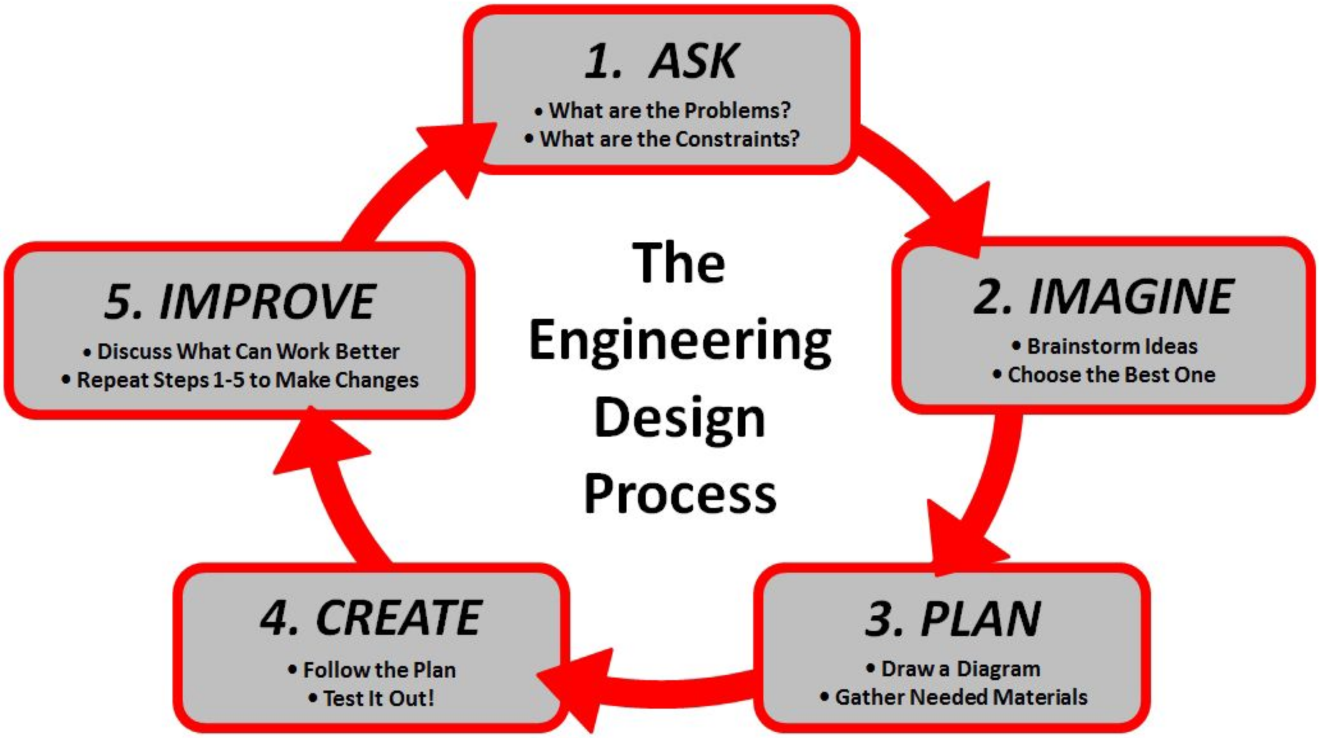
- The teacher will break students into teams of 4.
- The teacher will tell students that they will be working collaboratively to solve a problem.
- The teacher will explain that it is important to work well together as a team, so the students will be working on a challenge together to help build teamwork.
- The teacher will assign and define team roles (i.e. task manager/resource manager/facilitator). It is also an option to allow students to choose their own roles by deciding together with their team.
- The teacher will instruct the students that they will be working as a team on a short project challenge.
- The teacher will introduce the Marshmallow Challenge:

  Marshmallow Challenge. In eighteen minutes, teams must build the tallest free-standing structure out of 12 sticks of spaghetti, one yard of tape, one yard of string, and one marshmallow. The marshmallow needs to be on top with the structure standing.

- The teacher will pass out the materials for the marshmallow challenge.
- **Marshmallow Challenge Materials:** Each team needs 1 **yard** of **tape**, 1 **yard** of **string**, 20 pieces of spaghetti (uncooked, of course), and one marshmallow, one or two pairs of scissors per team. *Remind students that these are the only materials they will get, they cannot eat the marshmallow and if the spaghetti breaks they do not get more.

Image retreived from: www.teacherspayteachers.com/Product/Marshmallow-Challenge-Handout-1264032?utm_campaign=TransactionalEmails&utm_source=sendgrid&utm_medium=email

- Have students complete the marshmallow challenge while teacher walks around to facilitate.
- Once the activity is complete the teacher will lead a discussion asking teams to share what worked for them and what didn't, as well as the obstacles they encountered along the way.
- The teacher may show the following video of a team of students completing the challenge and ask students to compare/contrast that process with their own. Video: https://youtu.be/RtQr9w2pL74
- The teacher will illustrate that the teams solved problems using a plan, tested the plan and revised as needed. "This is the Engineering Design Process".
- The teacher will introduce the Engineering Design Process



- The teacher will post engineering design process diagram and ask students to discuss with their team what they think each step of the process will look like while they are working.
- The teacher will lead a class discussion where the teams can share their thoughts. The teacher will further define each step of the process.
- The teacher will tell students, that although the process is written in a circle with arrows showing the flow, their work may lead them to work through the project in a different order after the ASK and IMAGINE stages. For example, students may have to go back to the IMAGINE stage after the PLAN stage if they are struggling to create a plan based on their original brainstorming.
- The teacher will explain the students will be working on a much larger project starting tomorrow working with the same team and using the Engineering Design Process.

Days 2 and 3:

- **Hook:** the teacher will show this video to establish a foundation for the lesson : 4https://youtu.be/Ujm7l3h-CKk
- The teacher will explain that, not only does electricity consume fossil fuels which are non-renewable natural resources, it also is a major contributor to global warming.
- The teacher will explain that the school district has charged the class with developing a way to cut down on the use of electricity by developing a system that would allow one set of lights to light up several hallways at a time.
- The teacher will explain that the ASK part of the process will be given to the students, but the rest will be created and carried out by them.

- The teacher will share the driving question, which should remain posted for the duration of the lesson.

  Driving Question: How can we, as engineers, design a 3-D structure constructed of rectangular prisms, built from nets, that allow light to travel around a minimum of 3 corners?

- The teacher will explain that that is part of the ASK element of the engineering design process.
- The teacher will share the constraints anchor chart with students and explain that the constraints are the other piece of the ASK in the design process. This chart should remain visible throughout the project.
- The teacher will review how to create rectangular prisms using nets, and how light travels and reflects.
- The teacher will pass out the engineering design process template and instruct students to write everything they do on the chart under the corresponding labels as they work.
- The teacher will give students the opportunity to view the materials available for them to use for building their structure.
- The teacher will direct each team to begin to brainstorm ideas for a plan. Each team member to sketch their idea for a structure and write ideas on how to get the light to travel.
- When each student has a completed idea sketch and explanation, each team member should take a turn sharing his/her plan with the team.
- The team should discuss each plan and work together to decide on a plan to use, or a combination of more than one plan. The teacher should circulate and help facilitate discussions when necessary.
- Instruct students that their plan must be drawn to scale to reflect the actual size of the structure, which should emulate the size of the hallways in the school. The scale should be completed with accurate proportions. (i.e. if one block of graph paper equals one foot, then 5 blocks should be used for 5 feet).
- Give students the opportunities to measure the hallways for a baseline measurement.
- The team should create a formal sketch of their selected plan, including the materials they will use. The sketch should be labeled with actual dimensions, and should include a legend explaining the scale used.
- The teacher will review each plan for accuracy and the requirements.
- The teacher will instruct teams with approved plans to begin building the product, reminding them to follow their plan.
- The teacher will instruct students that, as they are building, any revisions should be noted on the plan, with an explanation of the reason for the revision, and if it worked or not.
- The teacher will remind students to record each step of their project on the Engineering Design Process Template.
- The students will demonstrate their working product upon completion. They should shine a flashlight through the front of the structure and the light should travel all the way around the structure and shine out the back of the structure.

Modifications:
Pre-Drawn nets for students to trace
Only require one or two corners

Extensions:
Add more turns into the structure
Add different angles into the structure
Add different 3-D shapes to the structure
Calculate the amount of energy that would be saved using the process the team developed
Create a graph showing the amount of energy that would be saved over a period of time

Assessments
Rubric

Points	Project Element
10	The plan is accurately drawn to scale and is labeled appropriately
10	The plan is neatly drawn, labeled, and includes improvements and how they worked
10	The finished structure reflects the original plan with noted revisions
10	The structure is free standing
10	The structure has at least 3 corners (90 degree turns)
25	The structure is composed of rectangular prisms created from nets
20	The Engineering Design Process is outlined on the template
25	The light passes through the entire structure
15	The brainstorming chart includes ideas from each team member
15	Each team member can explain the process they used to build the structure

Possible Points: 165 Points Earned: __________ Final Grade:___________

Formative Assessment:
Independently have students draw a net on graph paper, cut it out and form into a rectangular prism.

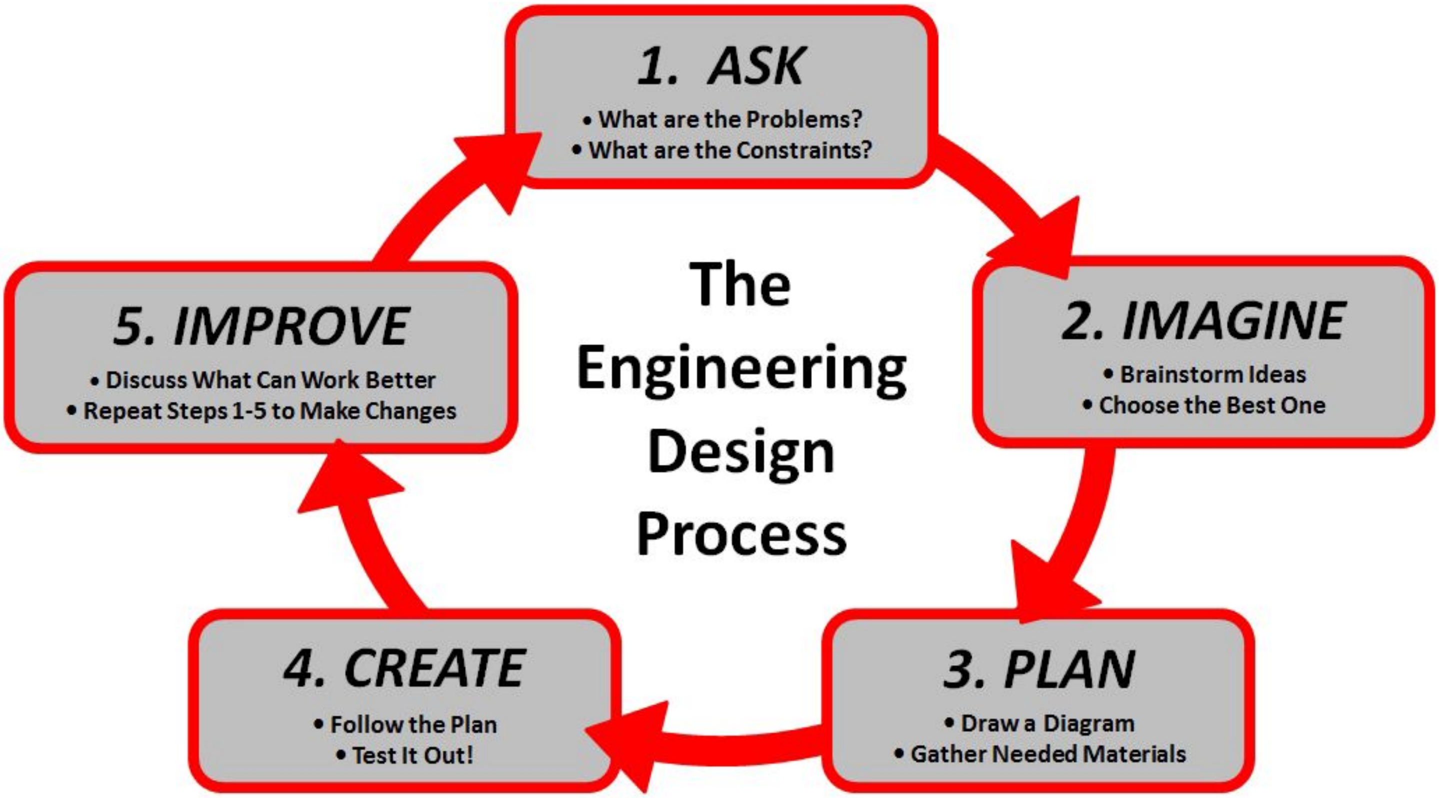


Image retreived from:
http://clickmakana.com/2016/04/05/the-engineering-design-process/

Engineering Design Process Template

Ask	Imagine	Plan	Create	Improve

Author Information

Kenan Fellow:

- I teach 6th Grade Math at Hilburn Drive Stem K-8 - Wake County
- I have been teaching for 8 years
- Email: meby@wcpss.net

Mentor:

- Dr. Elena Veety
- Dr. Veety received the Ph.D. degree in electrical engineering from North Carolina State University, Raleigh, NC, in 2011. Her research focused on liquid crystal polarization gratings for tunable optical filters and telecommunications applications. Since 2011, she has been a Teaching Assistant Professor of Electrical and Computer Engineering at North Carolina State University. Currently, she is the Education Director for the NSF Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST). In this role, Dr. Veety oversees the Center's education programs including dissemination of center research to the K-12 community, undergraduate research programs, undergraduate and graduate academic programs, as well as professional and translational skills training programs for graduate and undergraduate students.