

Standards-Based Lesson Template

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Class:	8th Grade Science
Lesson/Unit Title:	Engineering a Bridge
Abstract/summary of lesson:	<p>Abstract/Summary of Lesson: In order to help students further understand the engineering design process, they are going to design bridges that meet the various requirements necessary to successfully engineer bridge. In this case, students will learn about the various types of loads, how to calculate them and how to determine the appropriate beams and columns needed for the bridge. They will create their own smaller bridges to simulate all of the activities and steps taken by an engineer. Previous Knowledge: Students will have some basic knowledge of the engineering design process as well as types of forces and basic bridge design.</p>
Students will know...	<p>The effect of forces on objects of different sizes how the engineering design process works The importance of planning and design The different structural components to bridges</p>
Students will be able...	<p>Explain examples of the various load types Identify the factors that can affect a bridge's sustainability Identify and describe the different load types Identify and explain the purpose of columns and beams Design a bridge in order to meet the specific load requirements necessary for the area Calculate various loads</p>
Standards/Skills addressed	<p>Standards: MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.</p> <p>MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</p> <p>MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</p> <p>Solve real-world and mathematical problems involving the four operations with rational numbers. (Grade 8)</p>

Performance tasks/projects:

The students will have a performance task to complete at the end of the lesson series that will encompass several components:
Students must use their knowledge of forces and bridge designs to construct a model using clay, marshmallows, memory foam, and a combination of various sizes of popsicle sticks and test varying load amounts.
Students will need to collect data by testing their model
Students will interpret the data collected from their tests to reflect on their design.
They will refine their design and construct their final bridge using the materials provided.

Test and quiz questions or essay prompts:

Essay Prompt:
Why is the engineering design process is a vital component of designing bridges?

Test/Quiz Questions:

PreTest: Fill in the Engineering Design Process Worksheet which asks that students match the description to the proper step of the process.

Quiz:

Define force.

Explain what a dead load is and provide an example.

Explain what a live load and provide an example.

Identify the environmental load from the picture below

Explain the purpose of a column and sketch a picture.

Explain the purpose of a beam and sketch a picture.

Other evidence to be used (e.g., observations, evaluation of work samples, discussion):

Other evidence to be used: During the PowerPoint, students will create a trifold brochure to explain the different load types. For homework, the students will show examples for each with a brief explanation.

After creating their individual brochures, the students will work in their table groups to create a poster with a new example of each load type as well as brief explanation. They will present as a group to another group in the classroom. After they have spoken with two other groups, the teacher will facilitate academic discourse to review the various types and will create an anchor chart to record these examples. During this time, students will be required to justify their answers and state whether they respectfully agree/disagree with their peers and why or why not. Afterwards, students will have an opportunity to make changes to their brochures, if necessary. If they make changes, they will use post-it notes so that they can their growth.

Student self-assessments:

Student self-assessments: Students will evaluate their brochure based off of their work only, using the 1-4 engineer scale.

4- Thriving Engineer

3- Growing Engineer

2- Sprouting Engineer

1- Budding Engineer

Students will also be able to reflect on their growth from their brochures.

Objectives

Explain examples of the various load types
Identify the factors that can affect a bridge's sustainability
Identify and describe the different load types
Identify and explain the purpose of columns and beams
Design a bridge in order to meet the specific load requirements necessary for the area
Calculate various loads

Motivation:

I will ask students to raise their hand if they have ever traveled over a bridge?
I will then ask them if they have ever seen signs on a bridge that look like the following? (signs will include truck weight limit of _____, no trucks on the bridge, etc.)
Why do we think these signs are before these bridges?
We will then have a discussion as to why these signs are there and what could happen if these signs weren't there.
This will lead us into the beginning of the lesson as we talk about the importance of planning and designing bridges before beginning construction.

Presentation:

Vocabulary: force, load types (environmental, live and dead load), column, beam, compression and tension.
Teacher will facilitate student learning through guided academic discourse, powerpoints, lectures and videos.
I will use a PowerPoint that explains each load type to the student and provides them with several examples of each. I will ensure I discuss non-examples as well so that students can see the difference between an actual example and a non-example.
I will explain the work that I was able to observe firsthand during my internship and be sure to reiterate that this is a process.
I will also demonstrate how to use the bridge designer so that students can play around with their idea before they begin building their bridge for their performance task.
Students will facilitate their own learning by utilizing a few websites to help them research the necessary information for their performance task.
These include: <http://engineering.jhu.edu/ei/bridge-designer/>, <https://www.linkengineering.org/>, <https://www.engineergirl.org/>, and <https://www.uspto.gov/kids/>.
- Students will also participate in think pair share and small group discussions during the powerpoints and research to increase their ideas and gain new knowledge from their peers.

Application/Activities:

There will be several activities students will engage in. The first activity that they will do is to draw a bridge and label the forces. The second activity that they will do will be to review the engineering design process and after discussing bridges, we will talk about the importance of using this process to design and construct bridges. The third activity students will engage in will be creating a trifold brochure explain each load during the powerpoint. They will then have to come up with their own example for each. The next activity will find them working with a group to create a poster. Each group will be assigned a load type and they will need to come up with their own definition as well as examples and a justification for how they know that that load is that specific load type. The posters will lead into an academic discourse session where students will reflect on their own brochures. After reflecting on their own brochures, students will have the opportunity to use post it notes to rewrite examples or justifications, if necessary. This will allow them to see how the engineering process works and that sometimes the same step is repeated several times. The next activity will be the math portion where students will practice calculating loads and in conjunction with the simulation will work on using the load total to determine the necessary beam and/or column needed to support the loads for that bridge. This part will also have a video and Google Slides Presentation to go with it. The last piece will be the performance task that students will complete as their summative assessment. (If students are struggling as a whole, they may be placed with a partner for this portion.) Students will also complete the pretest but this time they will be responsible for explaining each step of the engineering design process rather than matching.

Materials needed:

Chromebooks
Internet Access
Printer Paper
Poster Paper
Markers
Calculators
Simulation
Pictures of bridges
Pictures of various beams
Pictures of columns
Toothpicks
Popsicle sticks
Craft sticks
Tape
Hot glue
Marshmallows
Density cubes

Assessment/Evaluation:

Informal: pretest, calculating loads worksheet, brochure, poster
Formal: posttest, quiz and performance task

Closure/Reflection:

Students will now be able to understand and explain the various steps that go into planning a bridge.

In addition, they will have a real world relation that involves something they use everyday-transportation and bridges.

For closure I will ask students why is it important to use the engineering design process when tackling a project like designing and building a bridge?

This will lead us into other ideas where the engineering design process is used, in this case students will use it to complete their quarter project which will be to design a water bottle rocket that can safely protect an egg.