Unit 3: Engineering

Content Area:	**Engineering**
Course(s):	**STEM**
Time Period:	**Week 31**
Length:	**15 Days**
Status:	**Published**

Unit Overview

In this unit, students will learn the engineering process from start to finish in constructing a bridge. Students will begin this unit with researching various bridge designs and will discover what makes a sturdy bridge. Students will then work in teams to plan out, create a scale drawing, and actually manufacture a bridge made completely out of toothpicks. Students will build upon their knowledge of previous units in order to estimate the "cost" of constructing their bridge. Students have a budget that needs to be met, without going over, so it's imperative that students take their time during the design process.

Standards

	Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
	Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
SCI.6-8.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.
SCI.6-8.MS-ETS1-2.7	Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.
SCI.6-8.MS-ETS1-4.ETS1.B.1	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
SCI.6-8.MS-ETS1-3.ETS1.B.2	Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.
SCI.6-8.MS-ETS1-4.ETS1.B.2	Models of all kinds are important for testing solutions.
SCI.6-8.MS-ETS1-3.ETS1.C.1	Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.
CCSS.ELA-Literacy.WHST.6-8.2.c	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
CCSS.ELA-Literacy.WHST.6-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Essential Questions

1) Under what circumstances are certain bridge designs used?

2) How can one small error in the design process lead to catastrophic problems in bridge designs?

Application of Knowledge: Students will know that...

- A beam bridge is a fixed structure consisting of a series of steel or concrete beams placed parallel to traffic and supporting the roadway.
- A suspension bridge is a bridge in which the weight of the deck is supported by vertical cables suspended from larger cables that run between towers.
- A truss bridge is a bridge whose load-bearing superstructure is composed of a truss, a structure of connected elements forming triangular units.
- An arch bridge is a bridge with abutments at each end shaped as a curved arch.

Application of Skills: Students will be able to...

- Come up with a design for a portable speaker that can be easily mass produced.
- Compare and contrast the pros/cons of 4 bridge types.
- Construct a bridge that meets a set of given criteria that can hold a set amount of weight.

Assessments

- Journal logs: Will be used for students to share anything that worked out well during the design

process or anything unexpected they encountered.
- Bridge Project (self scoring rubric): students will be asked to grade themselves and their classmates on their bridge construction.
- Portable Speaker Proposal: students will be graded on the process by which they were able to create their portable speakers.
- Information from this unit will be included on a locally developed, end of course benchmark assessment that may take the form of a test, performance based project, or other summative assessment.

Suggested Activities

- Lighthouse Project: for this project students will be asked to design a lighthouse out of a minimal list of supplies in which they will use a simple circuit to power a light bulb on the top. Students will research various New Jersey lighthouses and must incorporate at least 1 distinct characteristic from a lighthouse into their own custom lighthouse.
- Steady Hand Game: for this activity, students will construct their own steady hand game (like those seen at carnivals and in the game "Operation"). Students must work with their teammate to construct a game that is challenging yet winnable. Students must correctly design a parallel circuit that will not only light a light bulb if they lose, but also ring an electric buzzer.
- Electric Fan: students will be given a set of materials and asked to design a hand held electric fan to keep you cool during those hot summer months.

Activities to Differentiate Instruction

Differentiation for special education:

- General modifications may include:
    - Modifications & accommodations as listed in the student's IEP
    - Assign a peer to help keep student on task
    - Modified or reduced assignments
    - Reduce length of assignment for different mode of delivery
    - Increase one-to-one time
    - Prioritize tasks
    - Think in concrete terms and provide hands-on-tasks
    - Position student near helping peer or have quick access to teacher
    - Anticipate where needs will be

- Content specific modifications may include:
    - Break a project up into small attainable goals that can be met each period.
    - Provide a basic truss bridge layout for help beginning the bridge project.

Differentiation for ELL's:

- General modifications may include:
    - Strategy groups
    - Teacher conferences
    - Modification plan
    - Collaboration with ELL Teacher
- Content specific vocabulary important for ELL students to understand include: arch, beam, suspension, truss, speaker, engineer, budget

Differentiation to extend learning for gifted students may include:

- Instead of having students construct a truss bridge, see if they can successfully create a suspension bridge that will hold a given amount of weight.

Integrated/Cross-Disciplinary Instruction

ELA: Practice formulating complete and grammatically correct responses for the given journal entries.

Engineering: Successfully create a truss bridge made completely out of tooth picks that will hold a given amount of weight.

Marketing: Come up with a design for a portable speaker that can be easily mass produced that appeals to a particular group of individuals.

Resources

www.learn2.stem101.org

STEM Labs for Middle Grades

Youtube videos: self directed videos that can help students along in the design process

21st Century Skills

CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.

CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.