AMP IT UP

Advanced Manufacturing & Prototyping Integrated to Unlock Potential

FUNCTIONS

Experimental Design

IT'S ELECTRIC!

Clean Energy Challenge

Teacher Preparatory Guide

Fall 2018

8EDM

AMP IT UP

Advanced Manufacturing & Prototyping Integrated to Unlock Potential

8^{th} Grade Math Experimental Design (8EDM)

"It's Electric!"

Clean Energy Challenge

Module Description	Students use an online simulation to collect data on the percentage of houses powered for different types and thicknesses of insulation for a solar thermal emergency power plant. Students reason quantitatively using the rate of change of the houses powered per insulation thickness in conjunction with a cost factor to decide on the most effect combination of insulation material and thickness for emergency backup power. The module covers basic GSE concepts in linear rate of change. *Module features the work of Dr. Asegun Henry of the Georgia Institute of Technology School of Mechanical Engineering.*	
Related Mathematics Georgia Standards of Excellence	***MGSE8.F.4*** *Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.*	
Module Timeline	**50-minute class periods:** 3 days Day 1: Section 1, Section 2 Day 2: Section 2, Section 3 Day 3: Section 3, Section 4	**90 minute blocks:** 2 days Day 1: Sections 1, 2, 3 Day 2: Sections 3, 4
Documents Included in the Download	<u>Student Materials Folder</u> • Student Edition (recommended to be printed double sided) • Student Worksheet Packet (recommended to be printed single sided) <u>Teacher Materials Folder</u> • Materials List • Annotated Teacher's Edition • Teacher's Edition • Teacher Preparation Guide • Videos	

5E Stage	Student Activities How will students engage actively in the three dimensions throughout the lesson?	Teacher Activities How will the teacher facilitate and monitor student learning throughout the lesson?
Engage How does the lesson capture student interest, activate prior knowledge, and connect to a complex question, global issue, or real-world problem?	● Students will be introduced to the challenge (*1.1, 1.2*) ● Students wil be introduced to Solar Thermal Energy, and the work of Dr. Henry. (*1.3, 1.4*) ● Students find a turbine that can power 120,000 homes and provide extra energy and are introduced to a computer simulation to investigate the challenge. (*1.5*)	● Guide students through the text to check for understanding. ● Play *Power Plants and Pollution* Video and *Dr. Henry* Video for students. ● Facilitate discussion regarding information needed to determine if the generator produces enough power for the whole city.
Explore How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem?	● Students will run initial simulation and collect data for 0%-30%. (*2.1*) ● Students will create ordered pairs from the data, then plot them to create a line. (*2.2*) ● Students will explore visualizing a line versus using the equation of a line to determine if the chosen generator is a good one for the community. (*2.3*)	● Facilitate investigation/simulation ● Provide additional support for students completing student sheets ● Facilitate discussion over questions/graphs ● Provide additional support for students with the graphing & extrapolation of data. ● Discuss vocabulary
Explain How does the lesson allow students to develop, share, critique, and revise their own explanations before connecting those to accepted scientific explanations and terminology?	● Students will investigate how solar thermal power plants work. (*3.1*) ● Students will design an investigation to determine *How does the type and thickness of insulation affect the amount of power produced by the solar thermal plant?* (*3.2*) ● Students will record information from investigation then write equation of a line that fits their given materials. (*3.2*) ● Students will create graphs with their discovered equation on the *Insulation Graph* student sheet. (*3.2*)	● Facilitate discussion about how solar thermal power plants work. ● Facilitate as students use the simulation to procedure write, collect data, and record data on *Insulation Procedure* student sheet. ● Model for student groups that have difficulty with collecting data or recording data. ● Provide groups with third material for investigation. ● Facilitate as students graph all three lines Model, if necessary.
Elaborate How does the lesson allow students to extend their conceptual understanding of the three dimensions through opportunities to apply knowledge, skills, and abilities in new experiences?	● Students transfer their tested material onto the *Insulation Procedure* student sheet and form ordered pair. (*3.3*) ● Student share their pair in a whole group setting and record from other students. (*3.3*) ● Student calculates the slope of the line. (*3.3*) ● Student writes the equation for each line. (*3.3*) ● Students compare the effectiveness of each material. (*3.3*)	● Facilitates and provides support for students during the share out as well as the equation of a line, providing modeling if necessary. ● Facilitates discussion of materials effectiveness as well as positive and negative slopes if desired.
Evaluate How does the lesson—through both formative assessments embedded throughout the lesson and a summative assessment that might coincide with the elaborate phase—make visible students' thinking and their ability to use practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions?	**Formative:** Ongoing questioning and discussion *(all sections)* **Summative:** Using the data collected and analysis students will make a recommendation, letter, about the type of insulation to use, providing evidence about the generator and the insulation materials from the experiment/simulation. (*4.1*)	

	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	3.1	3.2	3.3	3.4
Engage	—	—	—	—								
Explore						—	—	—				
Explain									—	—		
Elaborate											—	
Evaluate												—

Section 1 – The Clean Energy Challenge: Power Generation *(20 minutes)*

The focus of Section 1 is to provide students with a background of the Energy, and its daily use. Students are then introduced to the concept of where energy, specifically electricity, comes from. Students then have to consider the environmental impact of power plants and their emissions. Then students are introduced to the challenge of being a chief engineer for Solville power company and having to come up with the plan for the new power plant. Throughout the challenge students will work at the chief engineer to determine the best and most efficient power plant for Solville

Student then are introduced to the concept of a solar thermal power plant, which is more eco-friendly. The challenge is then transformed to determine the type of insulation necessary to maintain the hot liquid and not loose temperature into the surrounding ground. Student must consider the cost and insulation factors when making a decision. Students watch a video of Dr. Asegun Henry, a professor of mechanical engineering at Georgia Tech, who researches solar thermal power plants so that they liquid stays hot. Last students are introduced to the simulation.

Preparation

Materials	Student Pages
• Solville Financial Statement spreadsheet • Red colored pencils • Black colored pencils	• Financial Planning Sheet #1 • Break-even Graph student sheet
Prep the Day Before: Review the section and challenge. Review *Power Plants and Pollution*, and *Meet Dr. Henry* videos	

Planning

GSE	**MGSE8.F.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
CCSSM	**8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. **8.EE.B.6** Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at *b*.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Percent capacity	How might we determine if a power generating turbine provides enough power?	• Discussion Questions: **Participation**

Section 2 – Choosing the Right Equipment *(40 minutes)*

In order for students to understand if the turbine can power the town and determine the best insulator to utilize students will need to run an initial simulation to determine the speed at which the generator must be running to power enough houses.

This section reviews independent and dependent variables, creating ordered pair, graphing ordered part, and linear and nonlinear relationships. Finally, students are introduced to the concept of slope intercept form and how to write the equation using two points on the line through the Mathematical Verification student sheet.

Preparation

Materials	Student Pages
• Simulation found at: http://ampitup.gatech.edu/simulations • Ruler	• Simulation Data Student Sheet • Mathematical Verification Student Sheet
Prep the Day Before: Review section to anticipate any mathematical challenges that students may face Ensure that simulation can be assessed from chosen technology	

Planning

GSE	**MGSE8.F.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
CCSSM	**8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. **8.EE.B.6** Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at *b*.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Independent variable • Dependent variable • Linear relationship • Nonlinear relationship • Slope • Y-intercept	• Can this generator provide enough electricity for 120,000 homes and businesses in Solville?	• Discussion Questions: **Participation** • Simulation Data Student Sheet :**Formative** • Mathematical Verification Student Sheet: **Formative**

Section 3 – Maximizing Your Power *(60 minutes)*

During this section, students will learn how a solar thermal power plant works, with its basic functionality. Students are then introduced to the necessity for insulation to go over the pipes to reduce heat loss. Students use the simulation to investigate how the type and thickness of the insulation affect the amount of power the solar thermal power plant can produce. Student write their own procedures of how to test insulation materials from 0-5cm thickness. (Students only test 3 total materials, Adobe, Fiberglass, and teacher given) Students graph their three lines for insulation and do an analysis over their graph. Next students share out their teacher given insulation data analysis, all students should record the shared-out data then complete an analysis over all the insulation given 1 cm of insulation and 5 cm of insulation. Students then complete a mathematical analysis over the types and thickness of insulation.

Preparation

Materials	Student Pages
• Ruler • Colored pencils	• Insulation Procedure Student Sheet • Insulation Graph Student Sheet • Insulation Data Student Sheet

Prep the Day Before:
Predetermine groups insulation materials. (To scaffold, provide lower ability groups with easier insulation materials)
Review the section to anticipate mathematical challenges that students might face

Planning

GSE	**MGSE8.F.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
CCSSM	**8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. 8.EE.B.6 Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Receiver • Steam Drum • Turbine • Generator	• How does the type and thickness of insulation affect the amount of power produced by the solar thermal plant?	• Discussion Questions: **Participation** • Insulation Procedure: **Formative** • Insulation Graph: **Formative** • Insulation Data Student Sheet: **Summative**

Section 4 – The Plant Recommendation *(30 minutes)*

During this section, students will determine if the turbine will provide sufficient power, as well as make a recommendation about the type of insulation to use. Students must consider the amount of power produced as well as the material prices when making their recommendation. Student letters will include evidence about the generator and insulation materials gathered through the simulation.

Preparation

Materials	Student Pages
• Simulation data and analysis from previous days	• Clean Energy Recommendation Student Sheet

Prep the Day Before:

Review the section to anticipate mathematical challenges that students might face
Be ready to discuss with lower students claims, evidence, reasoning during the letter writing

Planning

GSE	**MGSE8.F.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x,y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
CCSSM	**8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. 8.EE.B.6 Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
	• What is the best insulation material to use for the solar thermal power plant and how thick should the insulation be?	• Discussion Questions: **Participation** • Letter of Recommendation to Mayor: **Summative**

Georgia Tech | Center for Education Integrating Science, Mathematics & Computing

This curriculum is produced by Advanced Manufacturing & Prototyping Integrated to Unlock Potential (AMP-IT-UP) supported by National Science Foundation Award #1238089 through Georgia Institute of Technology's Center for Education Integrating Science, Mathematics, and Computing (CEISMC).

For more information about AMP-IT-UP and to download our curriculum, please visit our website at www.ampitup.gatech.edu.