

Advanced Manufacturing & Prototyping Integrated to Unlock Potential

EXPRESSIONS AND EQUATIONS

Data-Driven Decision Making

POWER PAYOFF *Power Finance Challenge*

Teacher Preparatory Guide

Fall 2018

8DMM



Advanced Manufacturing & Prototyping Integrated to Unlock Potential

8th Grade Math Data-Driven Decision Making (8DMM)

"Power Payoff"

Power Finance Challenge

| Module Description | Students use previous solar thermal power plant simulation data in conjunction with other cost attribute data (i.e. insulation material cost, material transportation cost, worker pay, budget) for different global locations. Students reason quantitatively using a system of linear equations to decide on insulation material and thickness for their location. The module covers basic GSE concepts in linear systems of equations. | | |
|---|---|------------------------------------|--|
| Related Mathematics Georgia Standards of Excellence | MGSE8.EE.8 Analyze and solve pairs of simultaneous linear equations (systems of linear equations). MGSE8.EE.8c Solve real-world and mathematical problems leading to two linear equations in two variables. | | |
| Module Timeline | 50-minute class periods: | 90 minute blocks: | |
| | 5 days | 3 days | |
| | Day 1: Section 1 | Day 1: Sections 1, 2 | |
| | Day 2: Section 1,2 | Day 2: Sections 2, 3 | |
| | Day 3: Section 2 | Day 3: Section 3 | |
| | Day 4: Section 3 | | |
| | Day 5: Section 3 | | |
| Documents | Student Materials Folder | | |
| Included in the Download | • Student Edition (recommended to | be printed double sided) | |
| | Student Worksheet Packet (recommended) | mended to be printed double sided) | |
| | <u>Teacher Materials Folder</u> Materials List Annotated Teacher's Edition Teacher's Edition | | |
| | | | |
| | | | |
| | | | |
| L | | | |

| 5E Stage | Student Activities | Teacher Activities |
|--|---|---|
| , i i i i i i i i i i i i i i i i i i i | How will students engage actively in the three dimensions | How will the teacher facilitate and monitor student |
| | throughout the lesson? | 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 are introduced to the challenge (to make a recommendation for the insulation material to use for the power plant) (1.1) Students are introduced to the factors that will influence the city's decision (Expenses, Revenue, Profit, and Break-Even Point) (1.2) | Guide students through the text to check for understanding Highlight the idea of the individual factors and ensure that students understand what each factor encompasses. Facilitate discussion regarding information needed for the city to make their decision. |
| Explore How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem? | Students will be introduced to the simulation and will run the simulation to collect data for Adobe at 5cm. They will then take the information collected and put it on the <i>Financial Planning Sheet #1. (1.3)</i> Students will use <i>Solville Financial Statement</i> spreadsheet to do a basic analysis for expense, revenue, profit, and break-even point. (<i>1.4</i>) Students will find the break-even point by graphing lines then analyzing their graph (<i>1.5</i>) | Facilitate as students run simulation for Adobe at 5cm. Facilitate as students use the <i>Solville Financial Statement</i> spreadsheet. Facilitate discussion about <i>Solville Financial Statement</i> and data analysis. Facilitate and assist students determining equations of lines and graphing lines Facilitate discussion about the analysis and limitations of graphs. |
| 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? | Student utilize a system of equation method (teachers' choice) to solve for the break-even point (2.1) | Facilitate and assist students in determining the break-even point for the system for Adobe 5cm. Facilitate a discussion about the effectiveness of using a system of equation vs. graph or table for determining the break-even point. |
| <i>Elaborate</i> 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? | Student determine expenses, revenue, profit, and break-even point for a different insulation type. (This can be assigned by the teacher or chosen by the student just be sure all possible types are done) (2.2) Students share out their data and results to the remainder of class, other students record other group data. (2.3) Students utilize the decision-making matrix to make recommendations to the city. (3.2, 3.3) | Provide support to students in determining the expenses, revenue, profit, and break-even point for their insulation type. Ensure that all students are filling in missing data from other groups. Facilitate a discussion about using the decision-making matrix, as well as ensure that every student is completing the matrix. |
| 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 <i>(all sections)</i> Summative: Using the decision-making matrix, students will write a letter and data analysis. (3.4) | r, including information found within their simulation |

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

Section 1 – Financing the Solar-Thermal Power Plant (70 minutes)

The focus of Section 1 is to provide students with a background of the Power Finance Challenge. The students will act as a team of engineers that have been hired to make recommendations about which insulation materials to use when building the power plant. Throughout the module, students will analyze data to determine which type of insulation should be used on the pipes of the power plant and how thick the insulation should be. Their final decision will be based off of startup cost, amount of time it takes to break even, and how much profit can be made.

Students are also introduced to key terms they will need to be able to understand throughout the challenge including: Expenses, Revenue, Profit, and Break-Even Point. Students are then provided a brief overview of the simulation, as well as the financial statement spreadsheet, that will be utilized to determine the decision making factors. After students use the financial statement spreadsheet they are asked to graph the expenses versus the revenue.

Preparation

| Materials | Student Pages | | | |
|---|---|--|--|--|
| Solville Financial Statement spreadsheet | Financial Planning Sheet #1 | | | |
| Red colored pencils | Break-even Graph student sheet | | | |
| Black colored pencils | | | | |
| Prep the Day Before: | | | | |
| Review the section and challenge. | | | | |
| Complete section one for self to determine any sections that students may need additional support completing. | | | | |

<u>Planning</u>

| GSE | GSE MGSE8.EE.8 Analyze and solve pairs of simultaneous linear equations (systems of linear equations). | | | | |
|-------|---|--|--|--|--|
| | MGSE8.EE.8c Solve real-world and mathematical problems leading to two linear equations in two variables | | | | |
| CCSSM | HSA.REI.C.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. | | | | |
| | HSA.REI.C.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. | | | | |

| Key Terms and Concepts | Essential Questions | Assessment and Grading Opportunities |
|--|---|--|
| Trade-offs Expenses (start-up, yearly operating, cumulative) Revenue (gross yearly, net yearly, cumulative) Break-even point Slope | Why are trade-offs an important decision for businesses to consider when planning financial decisions? Why is the break-even point an important point for business decisions? | Discussion Questions: Participation Student Financial Planning Sheet #1: Formative Break-Even Graph Sheet: Formative |
| Slope intercept equationY-interceptEquation of the lines | What information can you determine when you graph a system of equation? Why is this helpful? Why is it not helpful? | |

Section 2 – Plant Design Investigation (70 minutes)

In order for students to understand the true break-even point accurately, students should solve for the break-even point using a system of equations. Student are asked to solve for the break-even point for 5cm of Adobe using a system of equations. (NOTE: The challenge allows for the teacher to use any method that is preferential for the teacher. You many also choose to jump out of the lesson for a day or two to go more in-depth with system of equations, or to provide a more complete lesson.)

Section 2.2 students determine which of the plant designs are actually workable in this challenge. The plant must be able to power 120,000 homes, which all insulations materials are unable to do. (NOTE: If You completed the Solar Energy Unit, a previous AMP-IT-UP challenge, your students should already know this information and you may skip this section of the challenge. You may want to remind your students of the materials the thickness through a discussion, or a slide projected on your board.) Students then complete Financial Planning Sheet #2, by determining the gross yearly revenue and net yearly revenue for each plant design that is deemed appropriate.

After students complete which can provide power to sell, they will be instructed to calculate their breakeven points. This should be completed using system of equations. The teacher should assign students/groups to complete one of the appropriate designs. It is appropriate for multiple groups to do the same design to ensure validity of data.

Preparation

| Materials | Student Pages | | | |
|--|---|--|--|--|
| Simulation (http://ampitup.gatech.edu/simulations) | Financial Planning Sheet #1 | | | |
| | Break-even System of Equation student sheet | | | |
| Prep the Day Before: | | | | |
| Determine a method that will be employed to divide students into groups | | | | |
| Review the section to anticipate mathematical challenges that students might | face | | | |

<u>Planning</u>

| GSE | MGSE8.EE.8 Analyze and solve pairs of simultaneous linear equations (systems of linear equations). | | | | |
|-------|--|---------------------|---|--|--|
| | MGSE8.EE.8c Solve real-world and mathematical problems leading to two linear equations in two variables | | | | |
| CCSSM | CCSSMHSA.REI.C.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.HSA.REI.C.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. | | | | |
| | | | | | |
| | | | | | |
| | Key Terms and Concepts | Essential Questions | Assessment and Grading Opportunities | | |

Section 3 – Making Decisions Based On Data (80 minutes)

During this section, students will gather the information about the insulation materials and thickness to make an informed recommendation about the power plant design. Students should consider: the size of the loan, the amount of time it takes to reach break-even, and finally the profit after break-even.

Students are introduced to the decision making matrix, which will be used to help guide their decisions. Students variables are pre-determined and they will work though coding the matrix to give them a visual representation of the data need to make their final recommendation. Students are provided direct instructions as to how to properly code the matrix in section 3.3.

Finally, students should use their decision matrix to make a recommendation to the Mayor of Solville. This should be written in a letter format, using correct grammar and complete sentences. The recommendation letter should consider the amount of loan requested, amount of time for break-even, as well as the profit impact. Students should utilize evidence and reasoning within their recommendation drawing from the matrix and prior knowledge and/or experiences.

Preparation

| Materials Student Pages | | | |
|---|---|--|--|
| Colored Pencils Decision Making Matrix | | | |
| | Financial Planning Sheet #2 | | |
| | Insultation Recommendation Sheet | | |
| Prep the Day Before: | | | |
| Poviow the section to anticipate mathematical challenges that students might face | | | |

Review the section to anticipate mathematical challenges that students might face

<u>Planning</u>

| FIUIII | rianning | | | | | |
|---------|---|--|--|--|--|--|
| GSE | MGSE8.EE.8 Analyze and solve pairs of simultaneous linear equations (systems of linear equations). | | | | | |
| | MGSE8.EE.8c Solve real-world and mathematical problems leading to two linear equations in two variables | | | | | |
| CCSSM | | | | | | |
| Key Ter | ms and Concepts | Essential Questions | Assessment and Grading Opportunities | | | |
| • Deci | sion Making Matrix | How can a matrix help you to visualize multiple factors that need to be considered for a decision? | Discussion Questions: Participation Decision Making Matrix: Formative Insulation Recommendation Sheet: Summative | | | |

Georgia L 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.



Copyright © Georgia Institute of Technology All Rights Reserved 2017