Advanced Manufacturing & Prototyping Integrated to Unlock Potential

6th Grade Math Experimental Design (6EDM)

Some Assembly Required

Packaging Challenge

Module Description	Students simulate packaging procedures to determine which procedure is the most consistent and efficient in order to make the most packages. Students will reason quantitatively using measures of center and variability to construct viable arguments for the best procedure. This module covers the basic concepts in measures of center and spread. *The module will feature the work of Dr. Ellery Ingall of Georgia Institute of Technology Earth and Atmospheric Sciences.*	
Related Mathematics Georgia Standards of Excellence	**MGSE6.SP.3** Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. Summarize and describe distributions. **MGSE6.SP.4** Display numerical data in plots on a number line, including dot plots, histograms, and box plots.	
Module Timeline	**50-minute class periods:** 5 days Day 1: Section 1 Day 2: Sections 1, 2 Day 3: Sections 2, 3 Day 4: Section 3 Day 5: Section 4	**90 minute blocks:** 3 days Day 1: Sections 1, 2 Day 2: Section 3 Day 3: Section 4
Documents Included in the Download	Student Materials Folder • Student Edition *(recommended to be printed double sided)* • Student Data Collection Sheets *(recommended to be printed double sided)* Teacher Materials Folder • 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?	• Discuss how students at school have decorated their lockers and connect it to the challenge. *(1.1)* • Discuss simulations and how engineers use it in practice. *(1.1)* • Read the challenge and discuss what is being asked. *(1.1)*	• Show students pictures of lockers to spark interest • Guide students through text • Facilitate a class discussion about experimental design
Explore How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem?	• Students will familiarize themselves with the kits. *(1.2)* • Students will read through Procedure #1 and discuss with their groups to check for understanding. *(1.2,3.2)* • Students will conduct four trials using Procedures 1 and 2 and record their results. *(1.2,3.2)*	• Monitor the groups during their trials to insure that each member is following the assigned procedure. • Act as quality control and verify that each kit is packaged correctly. • Assist students finding the mean, median, mode and range.
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 share their data with the class and graph the frequency of the completed packages in a histogram. *(1.3,3.2)* • Students will review mean, median, mode, and range then calculate the class data for Procedures 1 and 2. *(1.4,1.5,3.3)*	• Verify that students have recorded their data on their investigation sheet. • Monitor students in their discussion about their recommendations to Ms. Hinkleberry. • Assist students in writing their letter.
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 will gain extra practice with mean, median, mode, and range by analyzing employee data by completing the Factory Data Interpretation Sheets #1 and #2 *(2.1, 4.1)*	• Assist students finding the mean, median, mode and range.
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)* Investigation Sheet #1 *(1.2, 1.5)* Investigation Sheet #2 *(3.2, 3.3)* Factory Data Interpretation Sheet #1 *(2.2)* Factory Data Sheet #1 *(2.1, 2.2)* Summative: Letter to Ms. Cassandra Hinkleberry student sheet *(3.4)* Factory Data Sheet #2 *(4.1)* Factory Data Interpretation Sheet #2 *(4.1)*	

	1.1	1.2	1.3	1.4	1.5	2.1	2.2	3.1	3.2	3.3	3.4	4.1
Engage	—											
Explore		—							—			
Explain			—	—	—				—	—		
Elaborate						—						—
Evaluate		—			—	—	—		—	—	—	—

Section 1 – Pack Those Kits! *(75 minutes)*

The focus of Section 1 is to introduce students to the Packing Challenge and their role as industrial engineers. Students will be placed in teams of 3-4 students to follow procedures for organizing materials for wall hanging kits. To assist with investigating the current procedure they will apply statistical measures to the data collected and will then engage in a class discussion where they compare data with their classmates.

Preparation

Materials	Student Pages
• Packaging Challenge Material Preparation Guide • 10 gallon size Ziploc Bags containing smaller Ziploc bags, Just Like Home Logo notecards • 10 canisters containing nut/bolt sets, dry wall anchors and picture hanging hooks • Procedure #1- Individual Assembly of Kits	• Investigation Sheet #1
Prep the Day Before: Prepare kits for Procedure #1- see Packaging Challenge Material Preparation Guide for more details.	

Planning

GSE	MGSE6.SP.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. Summarize and describe distributions. MGSE6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
CCSSM	CCSS.Math.Content.6.SP.A.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. CCSS.Math.Content.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Industrial Engineer • Measures of Center • Measures of Spread • Process • Procedure • Mean • Median • Mode • Range • Histogram	• How do you use measures of central tendency and variation to determine how effective and efficient the production process is?	• Discussion Questions: **Formative** • Participation: **Formative** • Investigation Sheet 1: **Formative**

Section 2 – Data From The Packaging Plant *(50 minutes)*

In this section students will continue to apply their knowledge of measures of center, measures of spread and regular arithmetic. They will analyze additional data about nine employees and how well they implement the current procedure for packaging kits. This analysis will help them determine how much variation there is throughout the day and how consistent the employees are at following the procedure.

Preparation

Materials	Student Pages
• N/A	• Factory Data Interpretation Sheet #1 Parts A & B • Factory Data Sheet #1
Prep the Day Before: Have student pages ready for distribution.	

Planning

GSE	MGSE6.SP.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. Summarize and describe distributions. MGSE6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
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Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Procedure • Mean • Median • Mode • Range • Histogram	• How do you use measures of central tendency and variation to determine how effective and efficient the production process is?	• Discussion Questions: **Formative** • Factory data interpretation sheet #1: **Formative** • Participation: **Formative**

Section 3 – Changing the Procedure *(75 minutes)*

During this section , students will use a simulation to represent the assembly line packing process. Through group data reporting, students will determne which measure of center and variability best describe the speed and consistency of this procedure.

Preparation

Materials	Student Pages
• Meals for Kids Video #1 • Flockheed Eggcraft Factory Video #2 • Packaging Material Preparation Guide • Procedure #2- Kit Assembly Line • Charlie Chaplin-Modern Times Video #3 • Gallon size Ziploc bags containing sandwich bags containing 32 nut and bolt sets, 64 drywall anchors, 64 picture hanging hooks, 16 logos per group • Sandwich size Ziploc bags containing 3 empty snack size bags per group	• Investigation Sheet #2 • Letter to Ms. Hinkleberry Student Sheet
Prep the Day Before: Prepare kits for Procedure #2- see Packaging Challenge Material Preparation Guide for more details. Have videos prepared for showing.	

Planning

GSE	***MGSE6.SP.3*** *Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. Summarize and describe distributions.* ***MGSE6.SP.4*** *Display numerical data in plots on a number line, including dot plots, histograms, and box plots.*
CCSSM	CCSS.Math.Content.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Experimental Design • Simulation	• How are simulations used to analyze experiments?	• Discussion Questions: Section 3.3 page 11 • Investigation Sheet 2 • Letter to Ms. Hinkleberry • Participation

Section 4 – New Data From The Packaging Plant*(50 minutes)*

Now that students have completed the simulation of the assembly line procedure, they will analyze the data to see if it supports the change from an individual assembly line to the assembly line.

Preparation

Materials	Student Pages
• Krispy Kreme Video • Factory Data Sheet #2 • Factory Data Interpretation Sheet 2 Parts A & B	• Student Edition • Factory Data Sheet #2 • Factory Data Interpretation Sheet 2 Parts A & B
Prep the Day Before: Video: Krispy Kreme	

Planning

GSE	MGSE6.SP.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. Summarize and describe distributions. MGSE6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
CCSSM	CCSS.Math.Content.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

Key Terms and Concepts	Essential Questions	Assessment and Grading Opportunities
• Mean • Median • Mode • Range • Histogram	• How do you use measures of central tendency and variation to determine how effective and efficient the production process is?	• Discussion Questions:Section 4.1 page 13 • Participation