

**7th Grade Math Data Visualization (7DMM)**

“*Perfecting Your Craft:*” Manufacturing Quality Control Challenge

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| **Module Description** | Students will use the measures of center and variability to determine if a production line has exceeded the allowable error rate and needs repair. During the module students will investigate the way sample size influences the understanding of actual results. To begin the module, each student is given a small sample of hex nuts to test for defects. They record their data and learn how to calculate error rates for their samples. Then, they will be grouped and compute the new error rates for their slightly larger sample, which they realize provides better insight. Finally, students will see how a reasonable, but even larger, random sample is best for making decisions. In the module, Spalding Nuts and Bolts, a local manufacturer of hex nuts, ask students to assist their Quality Control Manager in making decisions about their production lines. They are provided results from 4 random samples throughout the 16-hour production day for four different production lines. Students calculate and analyze the error rates to determine the status of each production line. The module culminates with students making a recommendation based on four possible options for each production line based on their data analysis.  |
| **Related****Georgia Standards of Excellence** | ***MGSE7.SP.1****: Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.****MGSE7.SP.2:*** *Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.****MGSE7.SP.3:*** *Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the medians by expressing it as a multiple of the interquartile range.****MGSE7.SP.4:*** *Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.* |
| **Module Timeline** | **50-minute class periods:**5 daysDay 1: Section 1Day 2: Section 1 & 2Day 3: Section 2Day 4: Section 3Day 5: Section 4 | **90 minute blocks:**2.5 daysDay 1: Sections 1 & 2Day 2: Section 2 & 3 Day 3: Section 4 |
| **Documents** **Included in the Download** | **Student Materials Folder*** Student Edition *(recommended to be printed double sided)*
* Student Worksheet Packet *(recommended to be printed single sided)*

**Teacher Materials Folder*** Materials List
* Annotated Teacher’s Edition
* Teacher’s Prep Guide
* Videos
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| **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 are shown a video to “hook” their interest in which hex nuts are used to make jewelry. (1.1)
* Students are introduced to the challenge (helping Spalding Nuts and Bolts (SNB) determine if their production lines are working well). *(1.1,1.2)*
 | * Show videos and facilitate class discussions. *(1.1)*
* Guide students through text to check for understanding. *(1.1, 1.2, 1.3)*
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| ***Explore***How does the lesson allow students to develop a common base of experiences by actively investigating the phenomenon or problem? | * Each student in a group of four is given a testing device and a sample of hex nuts to test for defects. *(1.2)*
* Students record their data while testing each hex nut. *(1.2)*
* Students calculate mean, median, and mode for their sample sizes. *(1.3)*
* Students calculate their error rate, their group’s error rate, and the class’s error rate. *(2.2, 2.3, 2.4)*
 | * Discuss the concepts of quality control and measures of center. Create groups of 4. *(1.2)*
* Distribute & demonstrate how to test hex nuts using the testing device. *(1.2)*
* Check that students are testing the hex nuts appropriately & recording data properly. *(1.2)*
* Check for accuracy when calculating mean, median, and mode. *(1.3)*
* Check for accuracy on error rate calculations. *(2.2, 2.3, 2.4)*
 |
| ***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 learn about random sampling and sample size through test reading. *(2.1)*
* Students explain the impact that a larger sample size has on the accuracy of their error rates. *(2.2, 2.3, 2.4)*
 | * Facilitate reading and discussion on the basics of random sampling and sample size. *(2.1)*
* Facilitate discussion after comparing the error rates for individuals, groups, then the class. *(2.4)*
* Display the results of all the error rates for individuals, groups, and the class a histogram. *(2.2, 2.3, 2.4)*
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| ***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 calculate the error rates for four samples for each production line. *(3.2, 3.3)*
* Students will transfer their data to the Decision Making Matrix, giving them a visual representation of their data for each production line. *(4.1)*
* Using a decision matrix, students will make recommendations for each of the four production lines, justifying their recommendations using their data. *(4.4, 4.5)*
 | * Facilitate a discussion on the reasoning behind taking multiple samples throughout the day for each production line. *(3.1)*
* Facilitate a class discussion on what might be causing different error rates. *(3.2)*
* Students visualize their data by transferring it to the matrix. *(4.1)*
* Facilitate a discussion around making informed decisions and justifying their teams’ decisions using data. *(4.2, 4.3)*
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| ***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)*Testing for Quality Sheet *(1.2, 1.3)*Error rate Information Sheet *(2.2, 2.3, 2.4)*Production Line #1 Error Rate Sheet *(3.1)*Production Line Comparison Sheet *(3.3)*Decision Making Matrix *(4.1, 4.4)***Summative:**Production Line Recommendation Sheet *(4.5)* |

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|  | **1.1** | **1.2** | **1.3** | **2.1** | **2.2** | **2.3** | **3.1** | **3.2** | **3.3** | **4.1** | **4.2** | **4.3** | **5** |
| **Engage** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Explore** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Explain** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Elaborate** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Evaluate** |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Section 1 – The Manufacturing Quality Control Challenge *(60 minutes)***

*The focus of Section 1 is to provide students with a background of the Manufacturing Quality Control Challenge. To capture their interest, in* ***Part 1.1****, the students are shown a video in which hex nuts are used to create jewelry. In the module, the students will assume the role of a quality control team for Spalding Nuts and Bolts (SNB), a local manufacturer of hex nuts. In this section students learn the importance of quality control as they view a video about the job of a quality control manager. In* ***Part 1.2****, Students will be given a set of quality requirements of size, height, and thread match as well as a testing device. In groups of four or five, each student will be given a sample of hex nuts to test using the testing device. Students will record their data on the Testing for Quality Sheet.* ***Part 1.3*** *includes a review of measures of center (mean, median, and mode) as well as a discussion on drawing inferences from the calculations which will set the stage for students to complete the module.*

***Preparation***

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| **Materials** | **Student Pages** |
| * Video #1: DIY: Hardware Inspired Jewelry
* Video #2: Quality Control Manager Interview
* Tray for each student
* Hex nuts and scoop
 | Testing for Quality Sheet |
| **Prep the Day Before:** Review the challenge and section. Review teacher annotated text.  |

***Planning***

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| **GSE** | ***MGSE7.SP.1:*** *Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.****MGSE7.SP.2:*** *Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.****MGSE7.SP.3****: Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the medians by expressing it as a multiple of the interquartile range.****MGSE7.SP.4****: Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.* |
| **CCSS** | ***CCSS.Math.Content.7.SP.A.1:*** *Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.****CCSS.Math.Content.7.SP.A.2****: Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.****CCSS.Math.Content.7.SP.B.3:*** *Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.****CCSS.Math.Content.7.SP.B.4:*** *Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.* |
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| **Key Terms and Concepts** | **Essential Questions** | **Assessment and Grading Opportunities** |
| * Quality control
* Quality requirements
* Inference
* Measures of center
* Mean
* Median
* Mode
 | * How do you select a valid sample to survey or study?
* What is the center of a set of data and how can it be described?
* How can data be used to compare different groups?
 | * Discussion Questions: **Participation**
* Testing for Quality Sheet: **Formative**
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**Section 2 – Analyzing Our Sample *(70 minutes)***

*To facilitate student learning* ***Part 2.1*** *provides background information concerning sampling and random sampling. In the challenge each group, working as a quality control team must make sure that all the production lines at SNB have very small error rates. In* ***Part 2.2*** *students calculate their own samples error rate and share each to plot on a histogram for the class to visualize this data. Then, in* ***Part 2.3****, the sample size is expanded to include their groups number of hex nuts. Once again, this data is shared and plotted for the class to view. Then lastly, in* ***Part 2.4****, the entire class numbers are used for the sample size and the data is plotted. Students learn how to calculate their error rates of their samples, compare it to the error rate of their group, then finally compare it to the error rate of the entire class. Through this activity, students realize that a larger sample size will provide more accurate data.*

***Preparation***

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| **Materials** | **Student Pages** |
| * Grid paper for histogram
 | * Error Rate Information Sheet
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| **Prep the Day Before:**  Review Class Discussion Questions and possible answers. Review teacher annotated text. |

***Planning***

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| **GSE** | ***MGSE7.SP.1:*** *Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.****MGSE7.SP.2:*** *Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.****MGSE7.SP.3****: Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the medians by expressing it as a multiple of the interquartile range.****MGSE7.SP.4****: Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.* |
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| **Key Terms and Concepts** | **Essential Questions** | **Assessment and Grading Opportunities** |
| * Sampling
* Random sample
* Error rate
 | * How can variation be described within a data set?
* How are proportions used to estimate information about populations?
 | * Discussion Questions: **Participation**
* Error Rate Information Sheet: **Formative**

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**Section 3 – Interpreting Data for Decision Making *(50 minutes)***

*In this section, the SNB Quality Control Manager has asked that the random samples be taken every 4-5 hours during the 16-hour production day with each sample consisting of 500 hex nuts.* ***In Part 3.1****, students are given the number of errors found out of 500 hex nuts and asked to calculate the error rate for 4 samples taken. Additionally, they determine the number of errors for a box of 100 hex nuts.* ***In Part 3.2****,**students watch the Nuts and Bolts Production Line video clip to familiarize them with the details of a real production line and give them some idea of where errors might occur.* ***In Part 3.3****,**students are given the number of errors found in all four samples from the four different production lines and asked to calculate the error rates. Student record their error rates on the Production Line Comparison Sheet.*

***Preparation***

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| **Materials** | **Student Pages** |
| Video #3: Nuts and Bolts Production Line | * Production Line #1 Error Rate Sheet
* Production Line Comparison Sheet
 |
| **Prep the Day Before**: Review Class Discussion Questions and possible answers. Review teacher annotated text. |

***Planning***

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| **Key Terms and Concepts** | **Essential Questions** | **Assessment and Grading Opportunities** |
| * Random sample
* Error rate
 | * Why do we use random samples to draw informal comparative inferences about two populations?
 | * Discussion Questions: **Participation**
* Production Line #1 Error Rate Sheet: **Formative**
* Production Line Comparison Sheet: **Formative**
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**Section 4 – Using a Decision-Making Matrix *(40 minutes)***

***In Part 4.1****, students are asked to transfer the error rates from the Production Line Comparison Sheet to the SNB Decision Matrix Sheet. Students will then color the error rates that are less than 1% green which are considered satisfactory. The error rates that are greater than 1% will be colored red and are unsatisfactory. This will allow students to easily visualize the data in a matrix and will assist the teams in making their recommendations. In* ***Part 4.2****, students read the text and understand that their challenge is to make the best decision based on the data.* ***Part 4.3****, describes the options available to the teams: Option 1: The production line is shut down and the equipment is inspected and repaired. Option 2: The line is shut down and all workers are given a refresher course.*

*Option 3: the production line continues to run and will be retested before taking any action. Option 4: The line is operating within acceptable levels and will continue to run. Finally, in* ***Part 4.4****, on the Production Line Recommendation Sheet, the teams will write a recommendation letter to the Quality Control Manager. Teams should include justifications for their decisions based on their data.*

***Preparation***

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| **Materials** | **Student Pages** |
| * Red and green color pencils
 | * Production Line Comparison Sheet
* SNB Decision Matrix Sheet
* Production Line Recommendation Sheet
 |
| **Prep the Day Before:**  Review Class Discussion Questions and possible answers. Review teacher annotated text. |

***Planning***

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| **GSE** | ***MGSE7.SP.1:*** *Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.****MGSE7.SP.2:*** *Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.****MGSE7.SP.3****: Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the medians by expressing it as a multiple of the interquartile range.****MGSE7.SP.4****: Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.* |
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| **Key Terms and Concepts** | **Essential Questions** | **Assessment and Grading Opportunities** |
| * Random sample
* Error rate
 | * How do we make decisions using data?
* How can we communicate scientific data?
 | * Class Discussion Question: **Participation**
* SNB Decision Matrix Sheet: **Formative**
* Production Line Recommendation Sheet: **Summative**
 |