# How Normal Are You?

**UNIT OVERVIEW & PURPOSE:**
This unit will focus on helping students understand and analyze normally distributed data and make predictions based on the results.

**UNIT AUTHOR:**
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**COURSE:**
Mathematical Modeling: Capstone Course

**CONTENT STRAND:**
Data Analysis

**OBJECTIVES:**
Students will be able to analyze normally distributed data. Including, but not limited to, calculating percentiles, normalizing data using z-scores, and determining probabilities based on the area under the standard normal curve.

**MATHEMATICS PERFORMANCE EXPECTATIONS:**

MPE 9        Design and conduct an experiment/survey. Key concepts include:
  a) Sample size;
  b) Sampling technique;
  c) Controlling sources of bias and experimental error;
  d) Data collection; and
  e) Data analysis and reporting

MPE 23      Analyze the normal distribution. Key concepts include:
  a) Characteristics of normally distributed data;
  b) Percentiles;
  c) Normalizing data, using z-scores; and
  d) Area under the standard normal curve and probability.

**CONTENT:**
Using proper sampling techniques, students will have the opportunity to explore and analyze real world data. They will learn how to compare individual elements within a given data set, relative to the mean of that data set, as well as relative to each other. They will learn what it means to have data that is normally distributed and how to make predictions based on that distribution. They will learn what it means to have an SAT score in the "94th percentile."

**REFERENCE/RESOURCE MATERIALS:**
Students will be tasked with collecting various sets of data from multiple sources. A ruler and tape measure will suffice for many of the tasks, a simple survey and/or direct observation should be sufficient to complete the tasks. Students will also use Microsoft Excel to create spreadsheets to manage and analyze the collected data.

**PRIMARY ASSESSMENT STRATEGIES:**
There will be both daily assessments and a cumulative evaluation.

**EVALUATION CRITERIA:**
At the end of each assessment there will be a copy of a rubric that is appropriately aligned with the assessment.

**INSTRUCTIONAL TIME:**
Two 90-minute blocks and one 45-minute block or three 90-minute blocks

# Lesson 1 "Let's see…"

**Strand**
Data Analysis

**Mathematical Objectives**
Students will begin their task of collecting the data prescribed on the attached sheet. A notebook, a brief survey of their classmates, direct observation, a ruler and a tape measure (centimeters or inches) and a calculator are all that are required to collect the data. Students will determine which individual data sets are quantitative and which are qualitative. Students will describe why they will analyze the quantitative data and not the qualitative data.

**Mathematics Performance Expectations**

MPE 9          Design and conduct an experiment/survey. Key concepts include:
   - f) Sample size;
   - g) Sampling technique;
   - h) Controlling sources of bias and experimental error;
   - i) Data collection; and
   - j) Data analysis and reporting

MPE 23         Analyze the normal distribution. Key concepts include:
   - e) Characteristics of normally distributed data;
   - f) Percentiles;
   - g) Normalizing data, using z-scores; and
   - h) Area under the standard normal curve and probability.

**Related SOL**

AII.9    The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

AII.11   The student will identify properties of a normal distribution and apply those properties to determine probabilities associated with areas under the standard normal curve.

**Materials/Resources**
   - Paper and pen/pencil to record data
   - Access to internet via computer lab, laptop or tablet
   - Microsoft Office software with Excel program.
   - Ruler and tape measure
   - Statistical z-score table
   - calculator

**Assumption of Prior Knowledge**
   - Students should be familiar with calculating mean, median, mode, and standard deviation.
   - Students should be comfortable accurately measuring small lengths/distances using a ruler or tape measure.
   - Students should be familiar with all aspects of data collection and statistic computation. Students might need guidance creating Microsoft Office Excel spreadsheets
   - Students will use data analysis including finding curve of best fit to complete the project.

- Students should be familiar with Google maps

**Introduction: Setting Up the Mathematical Task**
- Statistics are used in a variety of real-world scenarios. The first step in any statistical analysis is collecting data. In this lesson, students will be given a list of topics for which they will collect data. They will record and organize the data on an Excel spreadsheet. The instructor should remind the students there is a difference between quantitative and qualitative data, and the students should be prepared to distinguish between the two types. The instructor can ask if any students have experience with spreadsheets. The instructor can ask students if they have ever taken a test where their result is reported as being in a certain percentile (e.g. SAT).
- Students will be given the opportunity to work individually, in pairs or small groups (3-4). Given the time frame, the teacher can point out that collaboration will make the task go much faster.
- Students will share their findings with the class via oral presentation.
- By the end of class, students will understand how to collect and organize data, gain knowledge of various data analysis methods, learn how Excel is a vital part of any statistical presentation, and see the importance of collaboration.
- Students will have 90 minutes to complete all tasks.

**Student Exploration:**
- Students begin by (hopefully) choosing a partner, or partners, to work with.
- Students then begin collecting data listed on attached worksheet.
- After collecting the data, students will enter all data onto an Excel spreadsheet.
- Students will explore various uses of Microsoft Excel by watching the following series of videos:
  http://www.youtube.com/playlist?list=PLAT_s7jzgi40_6umve55unlHosR3Fm7Yz

  There are also directions attached with the worksheet.

- Students will then perform the following statistical calculations for each data set (where applicable) :
  o Mean
  o Median
  o Mode
  o Standard deviation
  o Students will create histograms and scatterplots as prescribed on the attached worksheet.
  o Students will then answer specific questions relating to z-scores and probabilities

**Teacher responsibilities**
- Monitor student progress through the data collection process
- Assist with accessing internet for Google maps and videos for Excel instruction
- Answer any students' questions relevant to the assignment

**Monitoring Student Responses**
- Students should communicate their thinking cooperatively with others in their group by working together to solve the problem at hand.
- Students should participate in group discussions using the vocabulary learned from previous lessons. Have students record any new vocabulary words in their math journal.
- Teacher should appropriately scaffold groups who are struggling to understand the general idea of the project, the technology of Microsoft Office Suite and the mathematics involved.
- As groups finish the lesson, instruct students to write on the board two things they learned during the lesson. Lead a classroom discussion based off of what the students wrote on the board.

- As a whole group ask students what they learned today regarding the use of qualitative data versus quantitative data.  Have them explain their reasoning.
- Near the end of class students will display their spreadsheet on the projector screen. This will allow for other students to look at what other students did. The teacher could then pose the question, "if you could do this activity over would you change anything about your methods based on what you saw others do?"

## Assessment
**Journal/writing prompts – Students are required to have a math journal.**
- Students should turn in the Excel spreadsheet with all the data sets and basic calculations
- Students should also turn in the answers to the follow-up questions
- Students should write a minimum of two paragraphs to the following journal prompts:
  "What is the significance of including (or excluding) qualitative data from your presentations? How will it affect your predictions? When performing a statistical analysis, what are some of the problems associated with having data that is qualitative as opposed to quantitative?"
- Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- A rubric is attached to track student achievement

## Extensions and Connections (for all students)
- Teacher can present a list of class grades from a particular assignment and have students calculate mean, median, mode and standard deviation. Students can then calculate his/her own z-score and percentile rank.
- Teacher can present any example of a statistical analysis found on any news program and lead class discussion.

## Strategies for Differentiation
- Give each student in the group a specific assignment
- Do not allow the group to turn in the assignment until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can begin to help others with data collection and/or calculations.
- If the class has a significant amount of ESL or ELL students, have the class summarize the websites in bullet point format before breaking into groups.  Include translation if needed.

**Collecting Data Instructions**

Your task is to collect and record all the following data for the entire class and enter the results on an Excel spreadsheet.

1) Age (months)
2) Height (centimeters or inches)
3) Arm span (fingertip to fingertip)
4) Head circumference (eyebrow level… centimeters or inches)
5) Male/female
6) Length of foot (heel to end of longest toe…centimeters or inches)
7) Width of foot (widest point…centimeters or inches)
8) Pulse rate (beats per minute)
9) Number of years in current school system
10) Neck circumference (base of neck… centimeters or inches)
11) Hand length (base of palm to tip of middle finger… centimeters or inches)
12) Wrist circumference (centimeters or inches)
13) Eye color
14) Knee to floor (top of kneecap…centimeters or inches)
15) Nose length (tip to eye level…centimeters or millimeters)
16) Ankle circumference (centimeters or inches)
17) Thumb length (centimeters or inches)
18) Elbow to tip of middle finger (centimeters or inches)
19) Eat breakfast?
20) Sum of the length of fingers (no thumb… centimeters or inches)
21) Distance between eye pupils (centimeters or inches)
22) Closed mouth length (centimeters or inches)
23) Open mouth diameter (top to bottom… centimeters or inches)
24) Head length (chin to crown… centimeters or inches)
25) Length/Height of ear (top to bottom… centimeters or inches)
26) Amount of loose change in pockets (cents)
27) Favorite subject in school
28) Average number of hours of sleep each night
29) How far away from school do you live? (use Google maps)
30) Glasses/contacts/neither
31) Play a sport for school?
32) Play a musical instrument for school (singing in chorus counts)
33) Width of hand (measured around knuckles…centimeters or inches)
34) Born in Virginia?
35) Born in the United States?
36) Distance from where you were born to where you now live (Google maps)
37) Vertical reach (flat foot…centimeters or inches)
38) Vertical reach (toe tips…centimeters or inches)
39) Buy school lunch or bring lunch
40) Number of siblings

**Questions for Statistical Analysis**          (answers to be included on the Excel spreadsheet)

1. Calculate the mean, median, mode and standard deviation for each data set where applicable.

2. Create 3 pairs of histograms and scatterplots. One pair should match two sets of quantitative data. One pair should match two sets of qualitative data. One pair should match one set of qualitative data and one set of quantitative data. Write a brief statement on any conclusions about correlations that can be made regarding the data sets you chose.

3. Choose any 2 of the *quantitative* data sets.

- For each set, select 4 data points **above** the mean and calculate the z-score of each point.
  1) For two of the points, find the probability that another data point will be <u>below</u> each point you choose.
  2) For the other two points, find the probability that another data point will be <u>above</u> each point you choose.

- For each set, select 4 data points **below** the mean and calculate the z-score of each point.
  Repeat steps 1 & 2

Use this link for the z-score table:          http://www.utdallas.edu/dept/abp/zscoretable.pdf

**Creating a Microsoft  Excel spreadsheet:**

I.          If using Excel 2013, watch:          http://www.youtube.com/watch?v=_PqnDYMO3lw

II.          If using Excel 2010, watch:          http://www.youtube.com/watch?v=MU0Dq2fA4QQ

III.          For older versions of Excel, use the following instructions:

          Begin by opening Excel from the Microsoft Office suite.

**Check to see if you have the Data Analysis ToolPak by clicking on the Tools drop down menu and look for "Data Analysis".  If you do not have the data analysis option, follow the following instructions to** load the Analysis ToolPak.:
  a)  On the **Tools** menu, click **Add-Ins**.
  b)  In the **Add-Ins available** list, select the **Analysis ToolPak** box, and then click **OK**.
  c)  If necessary, follow the instructions in the setup program.

To create a sample bell curve, follow these steps:
  1)  Enter the following column headings in a ***new*** worksheet:
      A1:Original  B1:Average  C1:Bin  D1:Random  E1:Histogram  G1:Histogram
  2)  Enter the following data in the same worksheet (enter your data here.  You will have considerably more than 8 pieces of data):
      - A2: 23     B2:
      - A3: 25     B3: STDEV
      - A4: 12     B4:
      - A5: 24
      - A6: 27
      - A7: 57
      - A8: 45

- A9: 19

3) Enter the following formulas in the same worksheet (you will want to use your data range):
   - B2:  =AVERAGE(A2:A9)
   - B3:
   - B4:  =STDEV(A2:A9)

These formulas will generate the average (mean) and standard deviation of the original data, respectively.

4) Enter the following formulas to generate the bin range for the histogram:
   C2: =$B$2-3*$B4

This generates the lower limit of the bin range. This number represents three standard deviations less than the average.

   C3: =C2+$B$4

This formula adds one standard deviation to the number calculated in the cell above.

5) Select Cell C3, grab the fill handle, and then fill the formula down from cell C3 to cell C8.

To create a histogram for the original data, follow these steps:
1) On the **Tools** menu, click **Data Analysis**
2) Click **Histogram**, and then click **OK**.
   a) In the **Input Range** box, type **A2:A9 (Use whatever your data range is)**.
   b) In the **Bin Range** box, type **C2:C8**.
   c) In the **Output Options** pane, click **Output Range**.
   d) Type **G2** in the **Output Range** box.
   e) Click **OK**.
3) Create labels for the legend in the chart by entering the following:
   - E14: =G1&"-"&G2
   - E15: =E1&"-"&F2
   - E16: =G1&"-"&H2
4) Select the range of cells, E2:H10, on the worksheet.
5) On the **Insert** menu, click **Chart**.
6) Under **Chart type**, click **XY (Scatter)**.
7) Under **Chart sub-type**, in the middle row, click the chart on the right.

**NOTE**: Just below these 5 sub-types, the description will say "Scatter with data points connected by smoothed lines without markers."

8) Click **Next**.
9) Click the **Series** tab.
10) In the **Name** box, delete the cell reference, and then select cell E15.
11) In the **X Values** box, delete the range reference, and then select the range E3:E10.
12) In the **Y Values** box, delete the range reference, and then select the range F3:F10.
13) Click **Add** to add another series.
14) Click the **Name** box, and then select cell E14.
15) Click the **X Values** box, and then select the range E3:E10.
16) In the **Y Values** box, delete the value that's there, and then select the range G3:G10.
17) Click **Add** to add another series.
18) Click the **Name** box, and then select cell E16.
19) Click the **X Values** box, and then select the range E3:E10.

20) Click the **Y Values** box, delete the value that's there, and then select the range H3:H10.
21) Click **Finish**.

The chart will have two curved series and a flat series along the x-axis.

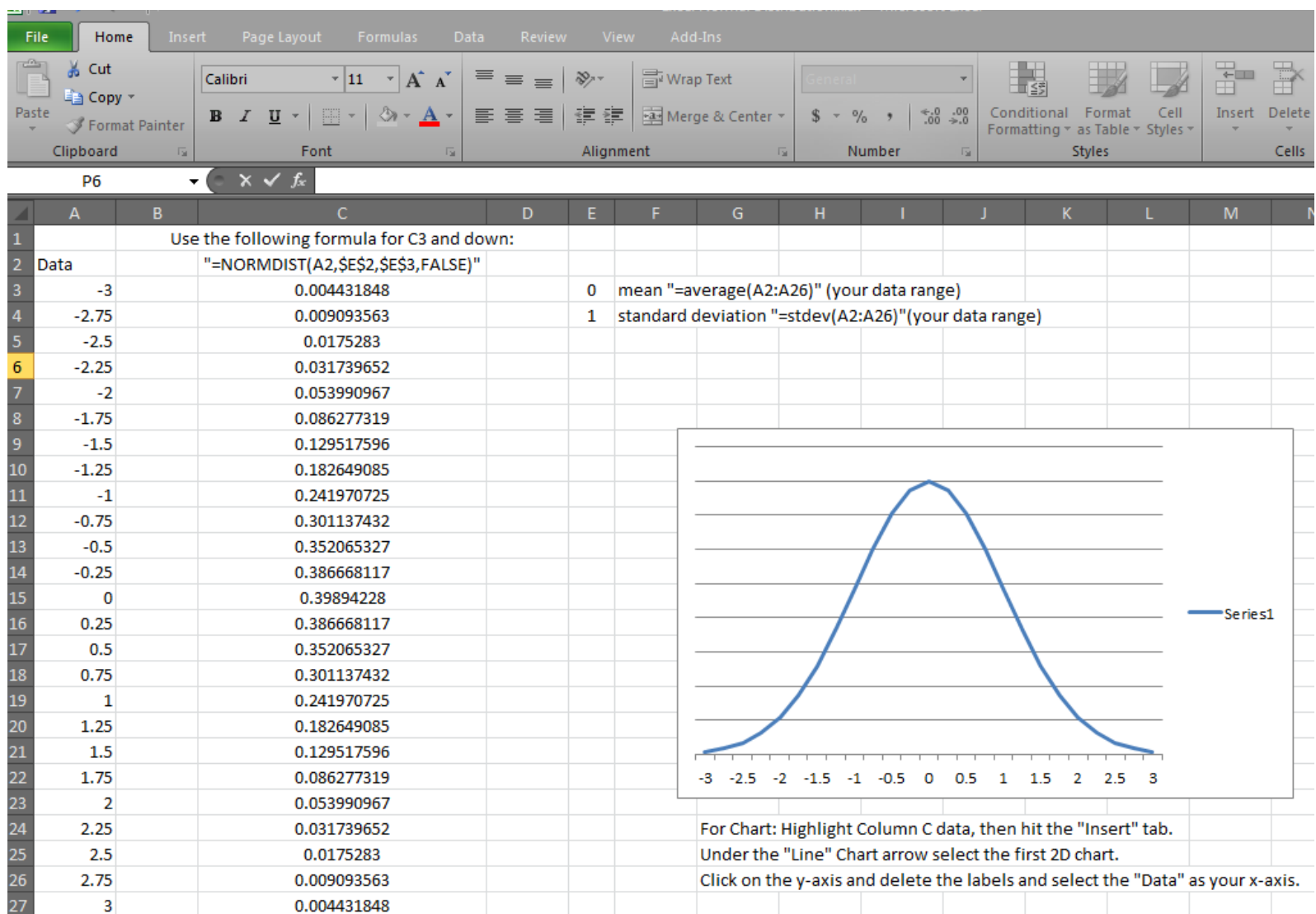22) Double-click the second series; it should be labeled "- Bin" in the legend.
23) In the **Format Data Series** dialog box, click the **Axis** tab.
24) Click **Secondary Axis**, and then click **OK**.

You now have a chart that compares a given data set to a bell curve.

Here is an example of what your spreadsheet should look like.

Please note, your data will be different.

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | | | Use the following formula for C3 and down: | | | |
| 2 | Data | | "=NORMDIST(A2,$E$2,$E$3,FALSE)" | | | |
| 3 | -3 | | 0.004431848 | | 0 | mean "=average(A2:A26)" (your data range) |
| 4 | -2.75 | | 0.009093563 | | 1 | standard deviation "=stdev(A2:A26)"(your data range) |
| 5 | -2.5 | | 0.0175283 | | | |
| 6 | -2.25 | | 0.031739652 | | | |
| 7 | -2 | | 0.053990967 | | | |
| 8 | -1.75 | | 0.086277319 | | | |
| 9 | -1.5 | | 0.129517596 | | | |
| 10 | -1.25 | | 0.182649085 | | | |
| 11 | -1 | | 0.241970725 | | | |
| 12 | -0.75 | | 0.301137432 | | | |
| 13 | -0.5 | | 0.352065327 | | | |
| 14 | -0.25 | | 0.386668117 | | | |
| 15 | 0 | | 0.39894228 | | | |
| 16 | 0.25 | | 0.386668117 | | | |
| 17 | 0.5 | | 0.352065327 | | | |
| 18 | 0.75 | | 0.301137432 | | | |
| 19 | 1 | | 0.241970725 | | | |
| 20 | 1.25 | | 0.182649085 | | | |
| 21 | 1.5 | | 0.129517596 | | | |
| 22 | 1.75 | | 0.086277319 | | | |
| 23 | 2 | | 0.053990967 | | | |
| 24 | 2.25 | | 0.031739652 | | | |
| 25 | 2.5 | | 0.0175283 | | | |
| 26 | 2.75 | | 0.009093563 | | | |
| 27 | 3 | | 0.004431848 | | | |

For Chart: Highlight Column C data, then hit the "Insert" tab.
Under the "Line" Chart arrow select the first 2D chart.
Click on the y-axis and delete the labels and select the "Data" as your x-axis.

# Grading Rubric – Data Collection

Group:_____

| | 7-6 | 5-4 | 3-2 | 1-0 |
|---|---|---|---|---|
| **Collected Data: Mean, Median, Mode, Standard Deviation** | Student collected and organized all data, student correctly calculated the appropriate values, all with little or no assistance from the teacher | Student collected and organized most or all of the data with assistance from the teacher, student correctly calculated the appropriate values with assistance from the teacher | Student collected and organized some or most of the data with assistance from the teacher, student correctly calculated most of the appropriate values with assistance from the teacher | Student collected little or no data, student poorly organized or did not organize the data, student incorrectly calculated all or most of the appropriate values or calculated irrelevant values |
| **Histograms & Scatterplots** | Student created accurate histograms and scatterplots, charts are correctly labeled and easy to read, line/curve of best fit accurately determined, all with little or no assistance from the teacher | Student created mostly accurate histograms and scatterplots, charts are labeled and usually easy to read, line/curve of best fit determined, all with assistance from the teacher | Student created some histograms and/or scatterplots or created ones that are inaccurate, some charts are labeled but not easy to read, line/curve of best fit determined only with assistance from the teacher | Student created inaccurate histograms and/or scatterplots, some or no charts are labeled and/or not easy to read, incorrectly determined or did not determine line/curve of best fit |
| **Z-scores & Probability** | Student calculated all z-scores and correctly determined associated probabilities, all with little or no assistance from the teacher | Student calculated most of the z-scores and determined associated probabilities with assistance from the teacher | Student calculated some of the z-scores and determined some of the associated probabilities with assistance from the teacher | Student calculated few or none of the z-scores and determined few or none of the associated probabilities |

# Lesson 2 Football…A Collision Sport

**Strand**
Data Analysis

**Mathematical Objectives**
Students will begin their task of collecting the data prescribed on the attached sheet. A notebook, a brief survey of their classmates, direct observation, ruler and tape measure (centimeters or inches), stopwatch and calculator are all that are required to collect the data. Students will describe why they will analyze the quantitative data and not the qualitative data. Students will make predictions based on the statistical analysis.

**Mathematics Performance Expectations**
MPE 9          Design and conduct an experiment/survey. Key concepts include:
- a) Sample size;
- b) Sampling technique;
- c) Controlling sources of bias and experimental error;
- d) Data collection; and
- e) Data analysis and reporting

MPE 23         Analyze the normal distribution. Key concepts include:
- a) Characteristics of normally distributed data;
- b) Percentiles;
- c) Normalizing data, using z-scores; and
- d) Area under the standard normal curve and probability.

**Related SOL**
AII.9    The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

AII.11   The student will identify properties of a normal distribution and apply those properties to determine probabilities associated with areas under the standard normal curve.

**Materials/Resources**
- Paper and pen/pencil to record data
- Access to internet via computer lab, laptop or tablet
- Microsoft Office software with Excel program.
- Ruler and tape measure
- Stop watch
- Statistical z-score table
- calculator

**Assumption of Prior Knowledge**
- Students should be familiar with calculating mean, median, mode, and standard deviation.

- Students should be comfortable accurately measuring small lengths/distances using a ruler or tape measure as well as using a stop watch
- Students should be familiar with all aspects of data collection and statistic computation. Students might need guidance creating Microsoft Office Excel spreadsheets
- Students will use data analysis including finding curve of best fit to complete the project.

## Introduction: Setting Up the Mathematical Task

- Students are tasked with selecting uniforms and equipment for the school football team. Using the students in class as a sample of the school student body, students will collect and analyze various sets of relevant data. The instructor can ask if any students have experience with sports, sports team management, budgets or market analysis. Students will have to research how many players are on the school football team and what type of equipment they need to purchase.
- Students will be given the opportunity to work in pairs or small groups (3-4).
- Students will share their findings with the class via oral presentation.
- By the end of class, students will understand how to collect and organize data, gain knowledge of various data analysis methods, learn how Excel is a vital part of any statistical presentation, and be able to predict inventory
- Students will have 90 minutes to complete all tasks.

## Student Exploration:

- Using the list of data sets from the worksheet in Lesson 1, students select data that is relevant to the task. Students will also be given an opportunity to research a sample of data sets from a professional football team. Students should also consider other data sets they believe will be relevant and/or helpful.
- After collecting the data, students will enter all data onto an Excel spreadsheet.
- Students will explore various uses of Microsoft Excel by watching the following series of videos: http://www.youtube.com/playlist?list=PLAT_s7jzgi40_6umve55unlHosR3Fm7Yz

  There are also directions attached with the first lesson's worksheet.

- Students will then perform the following statistical calculations for each data set (where applicable) :
  o Mean
  o Median
  o Mode
  o Standard deviation
  o Students will create histograms and scatterplots as prescribed on the attached worksheet.
  o Students will then answer specific questions relating to z-scores and probabilities

## Teacher responsibilities

- Guide students through the data collection process, particularly which data to use
- Monitor student progress through the data collection process
- Assist with data collection by asking "Are there any other data sets from the first lesson that you think can be useful?" and "Are there any other data sets you can think of that you would like to use?".
- Answer any students' questions relevant to the assignment

## Monitoring Student Responses

- Students should communicate their thinking cooperatively with others in their group by working together to solve the problem at hand.
- Students should participate in group discussions using the vocabulary learned from previous lessons. Have students record any new vocabulary words in their math journal.
- Teacher should appropriately scaffold groups who are struggling to understand the general idea of the project, the technology of Microsoft Office Suite and the mathematics involved.

- As groups finish the lesson, instruct students to write on the board two things they learned during the lesson. Lead a classroom discussion based off of what the students wrote on the board.
- As a whole group ask students what they learned today regarding the use of qualitative data versus quantitative data. Have them explain their reasoning.
- Near the end of class students will display their spreadsheet on the projector screen. This will allow for other students to look at what other students did. The teacher could then pose the question, "if you could do this activity over would you change anything about your methods based on what you saw others do?"

## Assessment

**Journal/writing prompts – Students are required to have a math journal.**

- Students should turn in the Excel spreadsheet with all the data sets and basic calculations
- Students should also turn in the answers to the follow-up questions
- Students should write a minimum of two paragraphs to the following journal prompts:
  "How does the fact you are analyzing a football team change your sample from the class data you collected? What effects do you think will occur with the sample size and statistical results?"
- Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- A rubric is attached to track student achievement

## Extensions and Connections (for all students)

- Teacher can present a job description of a professional or college football team equipment manager, or have a professional address the class.
- Students can research a variety of professional and/or college football teams and compare/contrast historically or recently successful programs with non-successful ones.
- Students can research height/weight of college or professional football teams and create normal curves, then compare with the normal curves of their school's football team

## Strategies for Differentiation

- Give each student in the group a specific assignment
- Do not allow the group to turn in the assignment until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can begin to help others with data collection and/or calculations.
- If the class has a significant amount of ESL or ELL students, have the class summarize the websites in bullet point format before breaking into groups. Include translation if needed.

**Collecting Data for Football**

Here is the data list from Lesson 1. Select all relevant data that you feel is useful for ordering uniforms and equipment for your school's football team. You also need to consider other data relating to physical agility (timed run/sprint, vertical and horizontal jump, weight) and uniform size (S, M, L, XL). Feel free to add other data you might find relevant. You are using your classmates as a sample representing the entire student population.
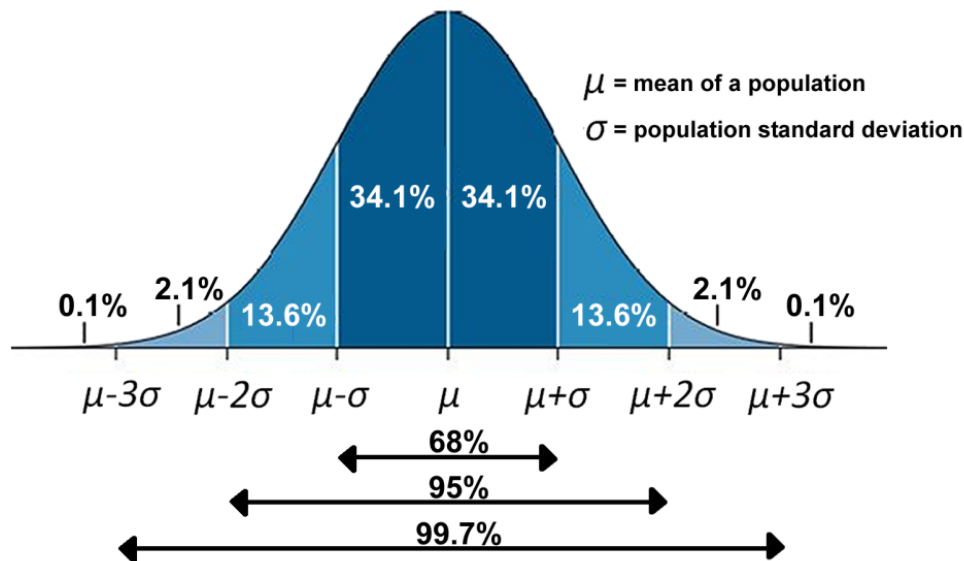
1) Age (months)
2) Height (centimeters or inches)
3) Arm span (fingertip to fingertip)
4) Head circumference (eyebrow level… centimeters or inches)
5) Male/female
6) Length of foot (heel to end of longest toe…centimeters or inches)
7) Width of foot (widest point…centimeters or inches)
8) Pulse rate (beats per minute)
9) Number of years in current school system
10) Neck circumference (base of neck… centimeters or inches)
11) Hand length (base of palm to tip of middle finger… centimeters or inches)
12) Wrist circumference (centimeters or inches)
13) Eye color
14) Knee to floor (top of kneecap…centimeters or inches)
15) Nose length (tip to eye level…centimeters or millimeters)
16) Ankle circumference (centimeters or inches)
17) Thumb length (centimeters or inches)
18) Elbow to tip of middle finger (centimeters or inches)
19) Eat breakfast?
20) Sum of the length of fingers (no thumb… centimeters or inches)
21) Distance between eye pupils (centimeters or inches)
22) Closed mouth length (centimeters or inches)
23) Open mouth diameter (top to bottom… centimeters or inches)
24) Head length (chin to crown… centimeters or inches)
25) Length/Height of ear (top to bottom… centimeters or inches)
26) Amount of loose change in pockets (cents)
27) Favorite subject in school
28) Average number of hours of sleep each night
29) How far away from school do you live? (use Google maps)
30) Glasses/contacts/neither
31) Play a sport for school?
32) Play a musical instrument for school (singing in chorus counts)
33) Width of hand (measured around knuckles…centimeters or inches)
34) Born in Virginia?
35) Born in the United States?
36) Distance from where you were born to where you now live (Google maps)
37) Vertical reach (flat foot…centimeters or inches)
38) Vertical reach (toe tips…centimeters or inches)
39) Buy school lunch or bring lunch
40) Number of siblings

**Questions for Football Team Equipment Inventory**    (answers to be included on the Excel spreadsheet)

1. Calculate the mean, median, mode and standard deviation for each data set where applicable.

2. Create a histogram and scatterplot based on two data sets that are relevant to each other.

3. Do you think your class sample will accurately reflect the student population at your school? If not, what changes or adjustments can be made? How do you think the data from your class sample set compares to that of your school's football team?

4. Research via internet 3 different companies for a list and cost of football equipment. Create a chart citing all three sources and total costs to equip the football team.

5. Based on results from the previous questions, decide which company would best suit your team's requirements (you must think about the financial situation in that your school does not have an unlimited budget). Keep in mind the following diagram when deciding on your purchase based on your data.

# Grading Rubric – Equipping Your Football Team

Group:_____

|  | **7-6** | **5-4** | **3-2** | **1-0** |
|---|---|---|---|---|
| **Selected/ Added Data** | Student selected all relevant data from the list, student added relevant data, all with little or no assistance from the teacher | Student selected most relevant data from the list, student added some relevant data, all with some assistance from the teacher | Student selected some or most relevant data from the list with assistance from the teacher, student added little relevant data | Student selected none or little relevant data from the list with assistance from the teacher, student added no relevant data |
| **Histogram & Scatterplot Using Relevant Data Sets** | Student created an accurate histogram and scatterplot using relevant data sets, charts are correctly labeled and easy to read, line/curve of best fit accurately determined, all with little or no assistance from the teacher | Student created histogram and scatterplot using mostly relevant data sets, charts are labeled, line/curve of best fit  determined, all with some assistance from the teacher | Student created histogram and scatterplot using some irrelevant data sets, charts are not labeled accurately, line/curve of best fit determined, all with assistance from the teacher | Student created histogram and scatterplot using irrelevant data sets, charts are not labeled, line/curve of best fit not determined |
| **Final Purchase** | Student researched costs from three vendors and selected appropriately and justified selection, student made correct purchase order based on normal distribution, all with little or no assistance from the teacher | Student researched costs selected a vendor, student attempted to justify selection, student made  purchase order based on normal distribution, all with some assistance from the teacher | Student researched some costs and needed assistance selecting a vendor, student made incorrect purchase order based on normal distribution, all with  assistance from the teacher | Student did not research costs and needed assistance or selected a vendor at random or did not justify selection, student made purchase order without basing on normal distribution |

# Lesson 3 Money! Money! Money! Let's Open a Store!

**Strand**
Data Analysis

**Mathematical Objectives**
Students will begin their task of collecting the data prescribed on the attached sheet. A notebook, a survey of their classmates, direct observation and a calculator are all that are required to collect the data. Students will determine which individual data sets are quantitative and which are qualitative. Students will describe why they will analyze the quantitative data and not the qualitative data. Students will make predictions based on the statistical analysis.

**Mathematics Performance Expectations**
MPE 9          Design and conduct an experiment/survey. Key concepts include:
a) Sample size;
b) Sampling technique;
c) Controlling sources of bias and experimental error;
d) Data collection; and
e) Data analysis and reporting

MPE 23         Analyze the normal distribution. Key concepts include:
a) Characteristics of normally distributed data;
b) Percentiles;
c) Normalizing data, using z-scores; and
d) Area under the standard normal curve and probability.

**Related SOL**
AII.9    The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

AII.11   The student will identify properties of a normal distribution and apply those properties to determine probabilities associated with areas under the standard normal curve.

**Materials/Resources**
- Paper and pen/pencil to record data
- Access to internet via computer lab, laptop or tablet
- Microsoft Office software with Excel program.
- Ruler and tape measure
- Statistical z-score table
- calculator

**Assumption of Prior Knowledge**
- Students should be familiar with calculating mean, median, mode, and standard deviation.
- Students should be comfortable accurately measuring small lengths/distances using a ruler or tape measure as well as using a stop watch

- Students should be familiar with all aspects of data collection and statistic computation. Students might need guidance creating Microsoft Office Excel spreadsheets
- Students will use data analysis including finding curve of best fit to complete the project.

## Introduction: Setting Up the Mathematical Task
- Students are tasked with selecting inventory to open a school store containing a variety of school spirit items. The size of the student population should figure in to your final decisions.
- Students will be given the opportunity to work in pairs or small groups (3-4).
- Students will share their findings with the class via oral presentation.
- By the end of class, students will understand how to collect and organize data, gain knowledge of various data analysis methods, learn how Excel is a vital part of any statistical presentation, and be able to predict inventory
- Students will have 90 or 45 minutes to complete all tasks.

## Student Exploration:
- Using the list of data sets from the worksheet in Lesson 1 and possibly new data sets from lesson 2, students will select data they believe is relevant to the task. Students can create new data sets based on class surveys and/or consider other data sets they believe will be relevant.
- After collecting the data, students will enter all data onto an Excel spreadsheet.
- Students will explore various uses of Microsoft Excel by watching the following series of videos: http://www.youtube.com/playlist?list=PLAT_s7jzgi40_6umve55unlHosR3Fm7Yz

  There are also directions attached with the first lesson's worksheet.

- Students will then perform the following statistical calculations for each data set (where applicable) :
  o Mean
  o Median
  o Mode
  o Standard deviation
  o Students will create histograms and scatterplots as prescribed on the attached worksheet.
  o Students will then answer specific questions relating to z-scores and probabilities

## Teacher responsibilities
- Guide students through the data collection process, particularly which data to use
- Monitor student progress through the data collection process
- Assist with data collection by asking "Which data sets from the previous lessons do you are useful?" and "Are there any other data sets you can think of that you would like to use?"
- Answer any students' questions relevant to the assignment

## Monitoring Student Responses
- Students should communicate their thinking cooperatively with others in their group by working together to solve the problem at hand.
- Students should participate in group discussions using the vocabulary learned from previous lessons. Have students record any new vocabulary words in their math journal.
- Teacher should appropriately scaffold groups who are struggling to understand the general idea of the project, the technology of Microsoft Office Suite and the mathematics involved.
- As groups finish the lesson, instruct students to write on the board two things they learned during the lesson. Lead a classroom discussion based off of what the students wrote on the board.
- As a whole group ask students what they learned today regarding the use of qualitative data versus quantitative data.  Have them explain their reasoning.

- Near the end of class students will display their spreadsheet on the projector screen. This will allow for other students to look at what other students did. The teacher could then pose the question, "if you could do this activity over would you change anything about your methods based on what you saw others do?"

## Assessment
**Journal/writing prompts – Students are required to have a math journal.**
- Students should turn in the Excel spreadsheet with all the data sets and basic calculations
- Students should also turn in the answers to the follow-up questions
- Students should write a minimum of two paragraphs to the following journal prompts:
  "Compare and contrast your statistics for the football team with the statistics you used for the school store. What are the similarities and differences?"
  "How do you think your answer would change if you were to compare your data to data collected for the girls tennis team?"
- Some groups may go into more detail than others with regards to the final reflection paragraphs. Considerations may be taken for ELL students or SWD.
- A rubric is attached to track student achievement

## Extensions and Connections (for all students)
- Teacher can present a job description of a local store manager, of have a professional address the class.
- Interview the manager of a local clothing store and ask them how they make their purchasing decisions. Then interview the manager of a large chain retailer (like Wal-Mart or Kohls) and ask how their clothing purchasing decisions are made.

## Strategies for Differentiation
- Give each student in the group a specific assignment
- Do not allow the group to turn in the assignment until everyone signs the worksheet stating that they understand how the numbers came to be.
- If some students finish quicker than others, they can begin to help others with data collection and/or calculations.
- If the class has a significant amount of ESL or ELL students, have the class summarize the websites in bullet point format before breaking into groups. Include translation if needed.
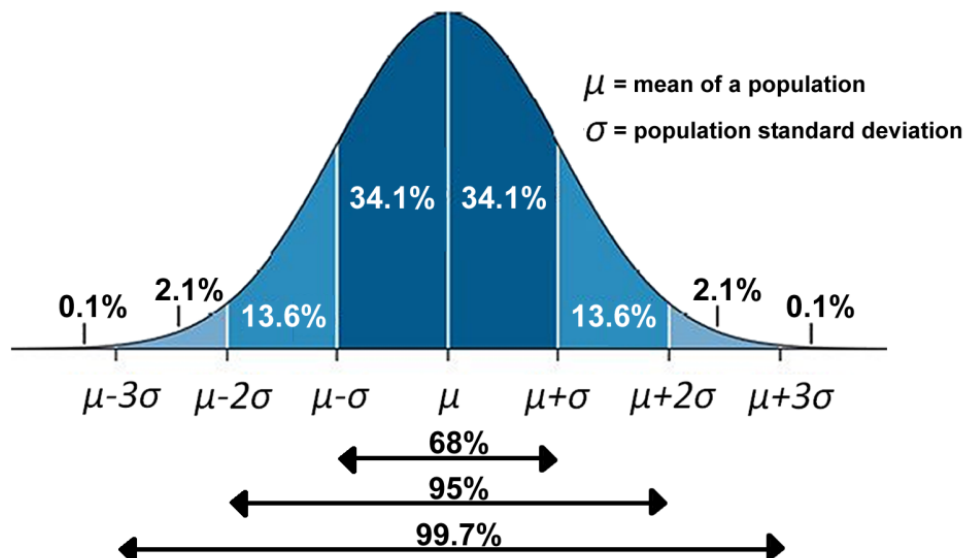
**Collecting Data to Open School Store**                    (answers to be included on the Excel spreadsheet)

You are tasked to assemble a variety of data sets relevant to the retail world. You are proposing to open a school store selling various clothing items with a school spirit theme. You may use any of the data sets from the first two lessons, and you may create additional data sets that are not listed by using your classmates as the sample group.

1. Decide which data sets will be relevant to the inventory of your store.

2. Create a histogram and scatterplot based on two data sets that are relevant to each other.

3. Do you think your class sample will accurately reflect the student population at your school? If not, what changes or adjustments can be made?

4. What do you think your histogram/scatterplot tells you about the purchases you should make for your store?

5. Research via internet 3 different companies for a list and cost of clothing you are planning to sell. Create a chart citing all three sources and total costs to stock your school store. Keep in mind many vendors provide discounts for multiple line purchasing.

6. Based on results from the previous questions, decide which company would best suit your store/customers (you must think about the financial situation in that your school does not have an unlimited budget). Keep in mind the following diagram when deciding on your purchase based on your data.



68-95-99.7 Rule

$\mu$ = mean of a population
$\sigma$ = population standard deviation

34.1%   34.1%
0.1%   2.1%   13.6%   13.6%   2.1%   0.1%
$\mu-3\sigma$   $\mu-2\sigma$   $\mu-\sigma$   $\mu$   $\mu+\sigma$   $\mu+2\sigma$   $\mu+3\sigma$
68%
95%
99.7%

# Grading Rubric – Opening School Store

Group:_____

| | **7-6** | **5-4** | **3-2** | **1-0** |
|---|---|---|---|---|
| **Selected & Added Data/ Histogram & Scatterplot** | Student selected all relevant data from the lists, student added relevant data, student created an accurate histogram and scatterplot using relevant data sets, all with little or no assistance from the teacher | Student selected most relevant data from the list, student added some relevant data, student created histogram and scatterplot using mostly relevant data sets, all with some assistance from the teacher | Student selected some or most relevant data from the list with assistance from the teacher, student added little relevant data, student created histogram and scatterplot using some irrelevant data sets | Student selected none or little relevant data from the list, student added no relevant data, student created histogram and scatterplot using irrelevant data sets |
| **Population Sample** | Student responded and justified use of sample population group, student correctly used normal distribution curve to make accurate purchases of inventory, all with little or no assistance from the teacher | Student responded to the use of the sample population group, student used normal distribution curve to make purchases of inventory, all with some assistance from the teacher | Student mentioned use of sample population group, student used normal distribution curve inaccurately to make purchases of inventory | Student did not respond or justify use of sample population group, student did not use or incorrectly used normal distribution curve to make purchases of inventory |
| **Final Purchase** | Student researched costs from three vendors and selected appropriately and justified selection, all with little or no assistance from the teacher | Student researched costs selected a vendor, student attempted to justify selection, all with some assistance from the teacher | Student researched some costs, needed assistance creating a chart and selecting a vendor | Student did not research costs, needed assistance or selected a vendor at random, or did not justify selection |