



PATRIOTS HALL OF FAME PRESENTED BY RAYTHEON

# SCIENCE AND MATHEMATICS



1. Data and Statistics.....pg. 2
2. Box Plots and Statistics.....pg. 5
3. A Model Field.....pg. 7
4. Physical Science(weight/mass; volume/mass).....pg. 9
5. Reaction Time(measurement/statistics).....pg. 11





# Lesson Plan 1:

## Data and Statistics

**Subject:** Mathematics

**Grade Level:** 3-5

**Objectives/Outcomes:**

- Collect numerical data, generate a line plot, and compare data sets.
- Find the mean, median and range of data sets.
- Communicate virtually with students as they are practicing their problem solving skills by finding the probabilities of simple events with likely and non-likely outcomes.

**Curriculum Framework Standards:**

- Data, Statistics and Probability

**Procedure:**

**1. “Frontloading” (Before)**

- a. Preparation and Planning
  - i. Students need to be familiar with the mathematical terminology:
    1. Data
    2. Line plot
    3. Mean
    4. Median
    5. Range

**2. Assistance and Associations (During)**

- a. Begin by discussing line plots - what they are and how you will use them to interpret data. Explain to the students that the line chart is a simple graph that follows data over time and it will be used for analyzing certain trends. Define the words mean, median, and range before proceeding.
- b. Ask the children who the New England Patriots are. Have a brief discussion about the Patriots.
- c. Share the New England Patriots regular season record from 1978-2019 with each student. Those are below or at the link here:  
<https://patriots.1rmg.com/season/2019/media-guide/>. Tell them that the data represents the Patriots total annual regular season wins over the past thirty-seven years.
- d. Ask the class how they should label the line plot. Have them label their line plot at this time.
- e. Tell each student to create their own line plot based on the data you have provided. An x should be used to represent the number of wins for each year.
- f. Call on volunteers to describe any similarities and differences they see.
- g. Once each student is done tell them they now need to find the mean, median, and range based on their data. Ask students to report their statistics they calculated. Also ask what year had the most wins and the least? Are there any years that had the same number of wins?





- h. More questions to extend the lesson:
- Suppose the Patriots had \_\_\_\_ wins in \_\_\_\_\_. How would that change our line plot?
  - Suppose the Patriots only had \_\_\_\_ wins in \_\_\_\_\_. How would that change our graph?

### 3. Reflection & Readiness for Application (After)

- Get data on touchdown passes that Tom Brady threw while the starting quarterback from 2001-2019 at [www.patriots.com](http://www.patriots.com).
- Create a line plot using this data and have each student calculate the mean, median, and range.

#### Assessment:

Use the following rubric to assess the students:

**3 points** The student actively participated in virtual class discussions and demonstrated a thorough understanding of the concept. The student correctly collected and displayed the data on the line plot and the answers for the mean, median and range are all correct.

**2 points** The student participated in most of the virtual class discussion and demonstrated a partial understanding of the concept. The student correctly collected and displayed the data on the line plot most of the time and the answers for the mean, median and range are mostly correct.

**1 point** The student did not participate in virtual class discussion and demonstrated only a limited understanding of the concept. The student correctly collected and displayed the data on the line plot some of the time and the answers for the mean, median and range may contain a correct answer but required work is not provided.

**0 point** The student did not participate in virtual class discussion and the line plot is inaccurate or incomplete.

#### Materials/Resources:

- Statistics of the New England Patriots Regular Season Record over the last 25 years
- Line Plot Paper
- Pencils
- Calculators





## New England Patriots Regular Season Record 1978-2019

Year	Record (wins/losses)
2019	12-4
2018	11-5
2017	13-3
2016	14-2
2015	12-4
2014	12-4
2013	12-4
2012	12-4
2011	13-3
2010	14-2
2009	10-6
2008	11-5
2007	16-0
2006	12-4
2005	10-6
2004	14-2
2003	14-2
2002	9-7
2001	11-5
2000	5-11
1999	8-8
1998	9-7
1997	10-6
1996	11-5
1995	6-10
1994	10-6
1993	5-11
1992	2-14
1991	6-10
1990	1-15
1989	5-11
1988	9-7
1987	8-7
1986	11-5
1985	11-5
1984	9-7
1983	8-8
1982	Players' strike-shortened season
1981	2-14
1980	10-6
1979	9-7
1978	11-5





## Lesson Plan 2:

### Box plot

**Subject:** Mathematics

**Course/Grade:** 6-8

**Objectives/Outcomes:**

- Research data from their favorite NFL player, current or historical. Wide receivers, running backs, and quarterbacks with more than 5 seasons of play will qualify for this project.
- Create box-and-whisker plots for the statistics of their favorite NFL players, correctly identifying scales, labels, and a title.
- Describe in words the trends of the graph. What are the shape, center, and spread of the box-plots? Calculate the mean, median, and mode of the distribution.
- Using the box-plots created, compare players of the same position by year and career. Which players performed at the highest level in one season? Which players performed at the highest level over the course of a career?

**Curriculum Framework Standard(s):**

- MCAS (Standard 8.D.2, 8.D.3)
  - Select, create, interpret, and utilize various tabular and graphical representations of data; e.g., circle graphs, Venn diagrams, scatter-plots, step-and-leaf plots, box-and-whisker plots, histograms, tables, and charts. Differentiate between continuous and discrete data and ways to represent them.
  - Find, describe, and interpret appropriate measures of central tendency (mean, median, and mode) and spread (range) that represent a set of data. Use these notions to compare different sets of data.

**Procedure:**

**1. “Frontloading” (Before)**

**a. Preparation & Planning**

- i. For either homework or a class opener, have the students research their favorite NFL player. For those unfamiliar with the NFL, a list of players may be provided and/or assigned.
- ii. Explain to students that they will be discussing how statistics of NFL players can be analyzed.
- iii. Students could find the following (all of which can be accessed via [www.nfl.com](http://www.nfl.com))
  1. Name
  2. Position
  3. Number of years playing in the NFL
  4. Write down the number of rushing yards (running backs), receiving yards (wide receivers) or passing yards (quarterbacks) for each season during which the player competed. Make sure students only fill out one statistic, as opposed to mixing the combinations of rushing and receiving yards.





## **2. Assistance and Associations (During)**

- a. Have the students find the mean, median, mode, minimum, maximum, and range for the data set.
- b. Explain the idea of an outlier and have students point out if there are any outliers in their data and possible explanations for why they exist.
- c. Create a box-plot, with accurate scaling and labeling. A quarterback scale could go from 0 to 5,000, while the running backs and wide receivers should go from 0 to 2,500.
- d. After one box-plot and calculations have correctly been made, the student could research up to 3 more players at the same position (they do not have to be Patriots players). Calculations should be made for the mean, median, mode, minimum, maximum, and range for the data set. The box-plot should be made and placed directly above or below previous box-plots.

## **3. Reflection & Readiness for Application (After)**

- a. To conclude, each student could write one paragraph summarizing his or her results. Here are some questions to consider – of the players researched, which gained the most yards, and how do you know? Which player had the highest median? The highest maximum? Which player had the greatest range?
- b. Split the students into virtual groups by the position of the player they picked. In other words, have all the students that chose a quarterback meet virtually, etc. Within the groups, have the students pick which player is the best, not based on the name of the player, but on yards produced by the respective positional statistic.
- c. To extend the lesson:
  - i. Some further ideas for analysis
    1. Students could research information about several more players, creating a paper as a potential extra credit assignment.
    2. Students could complete similar box-plot reports for other statistics in football
    3. Similar exercises would be useful for other sports: basketball and baseball would provide several statistics useful for analysis.





## Lesson Plan 3: A Model Field

**Subject:** Mathematics

**Course/Grade:** 7-8

**Objectives/Outcomes:**

- Research information on different measurements used in football
- Use formulas and research to identify area, and perimeter/circumference
- Compare these measurements to other sports and fields of interest

**Curriculum Framework Standard(s):**

- MCAS (Standards 8.M.1, 8.M.2, 8.M.3)
  - Select, convert, and use appropriate units of measurement or scale
  - Given the formulas, convert from one system of measurement to another. Use technology as appropriate
  - Demonstrate an understanding of the concepts and apply formulas and procedure for determining measures, including those of area and perimeter/circumference of parallelograms, trapezoids, and circles. Given the formulas, determine the surface area and volume of rectangular prisms, cylinders, and spheres. Use technology as appropriate

**Procedure:**

**1. “Frontloading” (Before)**

- a. Preparation & Planning
  - i. Research the length and width of a football field, basketball court, hockey rink, and a baseball field. Professional length fields or youth fields could be used, or for further analysis, both could be used and compared
  - ii. Access to graph paper and a ruler

**2. Assistance and Associations (During)**

- a. Using a common scale, have all students draw a model football field on a regular piece of graph paper. Consider a common scale or having more advanced students develop their own personal scale
- b. Calculate the area and perimeter, both in actual units (yards, feet, or inches) and model units (yards or centimeters). What are the ratios of the model unit to the actual unit for the area and perimeter? Is this the same as the scale used to draw the model?
- c. On another paper or on the backside of the original graph, students can draw a second model of a basketball court, hockey rink, or a baseball field (these may vary, online research required)
- d. Calculate the area and perimeter/circumference as in the second step above. Shapes could include a semi-circle (hockey), diamond (baseball), or a triangle (baseball).

**3. Reflection & Readiness for Application (After)**

- a. Consider having the students create a final draft of their model field (any sport is fine here). Look for a consistent scale, accurate measurements.





- b. On the football field, look to include yard markers at the correct marks on the model
- c. On the basketball court, look to include the half-court line, three-point line, and free-throw lines
- d. On the hockey rink, look to include face-off circles, and red/blue lines
- e. Comparison to youth dimensions, including area and perimeter, could also be included
- f. Think about:
  - i. Where in real life, apart from fields, are scales like these used?
  - ii. How can the scales be associated with mathematical terms like ratios and proportions?





## Lesson Plan 4: Physical Science

**Subject:** Science

**Course/Grade:** 4 – 6, 6 - 8

**Objectives/Outcomes:**

- To increase students' knowledge of the effects of temperature on an object using the Scientific Method.

**Curriculum Framework Standard(s):**

- Science/Technology
  - Physical Science Grades 6 – 8
    - Properties of Matter
      - Differentiate between weight and mass, recognizing that weight is the amount of gravitational pull on an object.
      - Differentiate between volume and mass. Define density.
      - Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits.
    - Heat Energy
      - Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.
  - Physical Science Grades 3 – 5
    - Properties of Objects and Materials
      - Differentiate between properties of objects (e.g., size, shape, weight) and properties of materials (e.g., color, texture, hardness).

**Materials:** See if any of your students have any of the following materials

- Football(s)
- Tape measures
- Scales or balances
- Access to a refrigerator
- Note taking equipment (either pen/paper or excel)

**Procedure:**

1. “Frontloading” (Before)-
  - a. Preparation & Planning
    - i. Before you begin- see how many students have footballs and football gloves they can use during your virtual class time.
    - ii. Visit websites below and watch short Patriots Snow Bowl highlights:
      1. <https://www.patriots.com/video/memorable-divisional-game-moments-320401> OR
      2. <https://www.patriots.com/video/2001-afc-divisional-playoff-snow-bowl-kick>



- iii. Make sure students have basic knowledge of the physical science related terms and relationships (temperature vs air density etc)
- iv. Review the Scientific Method/Process

## 2. Assistance and Associations (During)

- a. Question: Is kicking a warm football (think preseason) any different from kicking a cold football (think playoffs in New England)?
- b. Have students make hypothesis
  - i. Make sure students not only think about the snow, but about the playing surface, the temperature, the temp of the players, and most importantly the ball
- c. Collect Data
  - i. Have students make chart or table to input football data

"Superdome" (room temp)	"Seattle" (wet)	"Playoffs" (cold)

- ii. Start w/ brainstorming and observations about the physical characteristics of the ball – use the chart above to record these observations in the Superdome column:
  - 1. Shape
  - 2. Size
    - a. Diameter around laces
    - b. Diameter tip to tip
    - c. Volume – water distilling
    - d. Mass
  - 3. Color
  - 4. Texture
- iii. Have the students with footballs describe them. Have them be very detailed about what it feels like, how heavy it is and how it changes when they, squeeze it, bounce it, throw it, catch it, kick it – have all students use the chart to record observations while "playing" with the ball (once each at a regular dry room temp, wet, and cold and record in chart). Have the students without footballs ask questions about how the footballs feel under certain situations. Students can run the football under cold water for "Seattle" testing and either place the ball in the refrigerator or freezer for 30 minutes for "Super Bowl" testing.
- iv. Do it all again but w/ gloves

## 3. Reflection & Readiness for Application (After)

- a. Analyze and Interpret Data
- b. Draw a Conclusion (Final Statement)
- c. Any questions or suggestions?
  - i. Better ways to construct the football to minimize these differences?
    - 1. Different material?
    - 2. Different filler (hydrogen vs. air?)
  - ii. Dome games?
  - iii. Football heaters?



## Lesson Plan 5: Reaction Time

**Subject:** Math/Science

**Course/Grade:** Grades 6-8

**Objectives/Outcomes:**

- To measure the reaction time of an experiment and make comparisons with a standard as well as with other students in the virtual class room

**Curriculum Framework Standard(s):**

- Measurement, statistics

**Procedure:**

**1. “Frontloading” (Before)**

**a. Preparation & Planning**

- Find an assistant to help show as a model for classroom
- Ask assistant to extend hand and hold it out open with thumb and forefinger facing each other
- Hold ruler (with measurement in centimeters) so that the 0 is now between the subject’s finger and thumb
- Ask subject to catch the ruler when released with the thumb and finger
- Give no advanced warning as to when you are going to release the ruler
- Release the ruler and record the positioning on the ruler when it is caught (assuming that it is caught by the finger and thumb)
- Repeat the release at least 10 or 12 times with the subject. Check with the class for understanding
- When they are ready, have your students find a sibling, parent, guardian, etc. and begin the exercise checking frequently to make sure that they get it
- If doing it 12 times drop the highest and lowest and check the data (if doing it 10 times, simply record the data)

**2. Assistance and Associations (During)**

**a. The formula to test the reaction time is expressed as:**

**i.  $S = V_o \cdot t + \frac{1}{2} g t^2$**

Where: s= distance;  $V_o$ = initial dropping speed;  
g= gravitational acceleration of  $980 \text{ cm/s}^2$   
t= reaction time

**Or simply use the chart below (the chart will show, when you know how far the ruler has fallen, the approximate length of time it took to fall that far):**





CM	SEC	CM	SEC
10	.143	16	.181
11	.150	17	.186
12	.156	18	.191
13	.163	19	.197
14	.169	20	.202
15	.175		

### 3. Reflection & Readiness for Application (After)

- Name and discuss areas of football that would be affected by low/high reaction times.
- Discuss why reactions time might be important for different positions in football.
- Try this reaction drill with a dollar bill; to add to the frustration make sure that the finger and thumb are placed at George Washington's head prior to the release of the bill by a partner. (Unless there is some prompting, they probably won't catch the dollar)

