WELCOME TO *STATISTICS AND PROBABILITY FOR MIDDLE-SCHOOL MATH TEACHERS:*

ADDRESSING THE COMMON CORE

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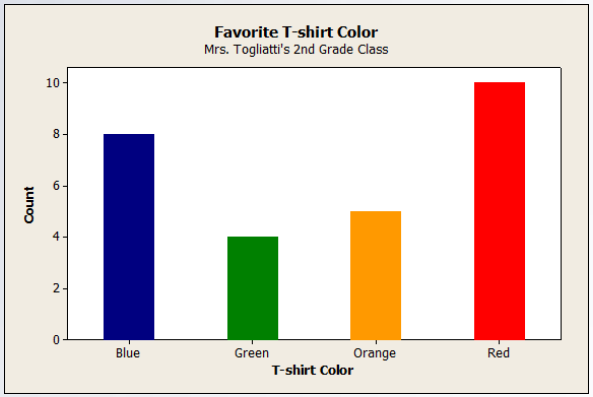
Karen Togliatti, Curriculum and PD Specialist

Mathematics Progressions

To see where the Statistics and Probability Domain fits into the progression of student learning, it is helpful to see where students have been and where they are headed in their understanding of these concepts.

K – 2 Categorical Data Progression

- Counting and order relations for categorical data (sorting)
- Addition and subtraction problems in a data context
- Draw a picture graph or bar graph for up to four categories with single unit scale
- Take length measurements to the nearest whole and plot on a line plot (measurement data)



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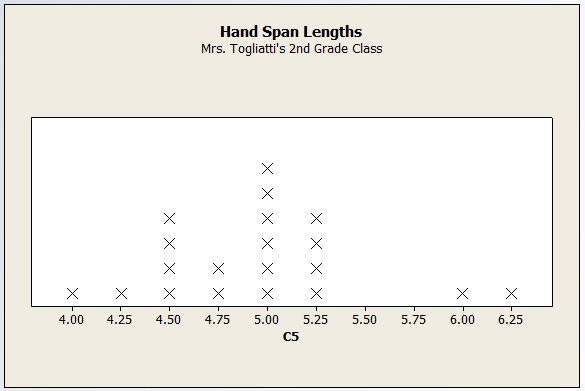
3 – 5 Measurement - Data

- Grade 3: Students can draw a scaled picture graph or a scaled bar graph to represent a data set with several categories.
- Students take measurement data with increasing precision and plot results along a scale.



- Choosing appropriate representations (MP5), attending to precision in measurement (MP6), and interpreting a data plot (MP2) are relevant practices.

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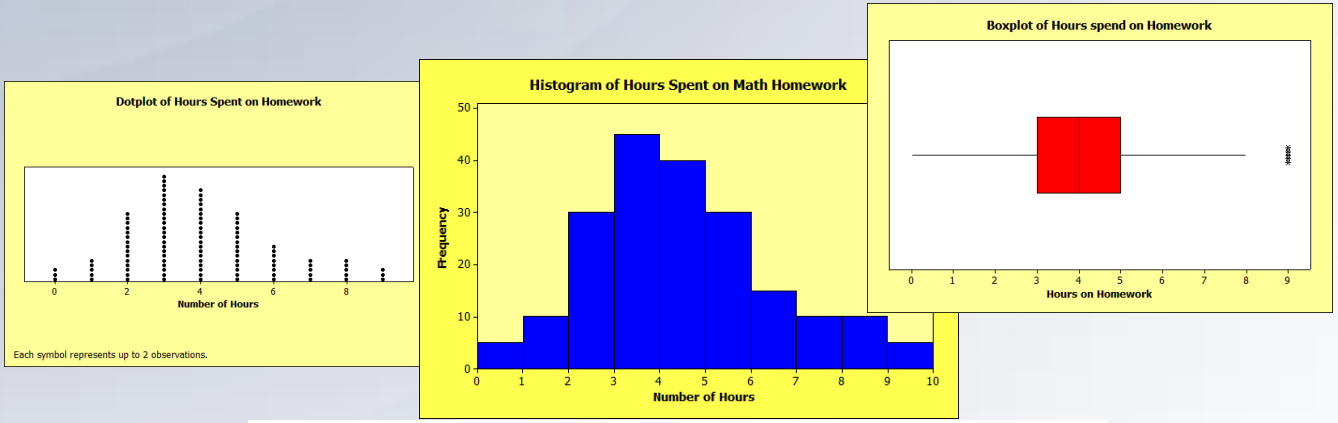
Grade 6

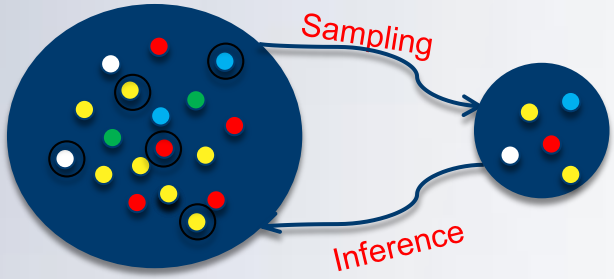
- Students in Grade 6 develop a deeper understanding of variability.
- Descriptions of data distributions are more precise, and numeric measures of center and spread are applied to quantitative data.
- Statistical reasoning is developed.



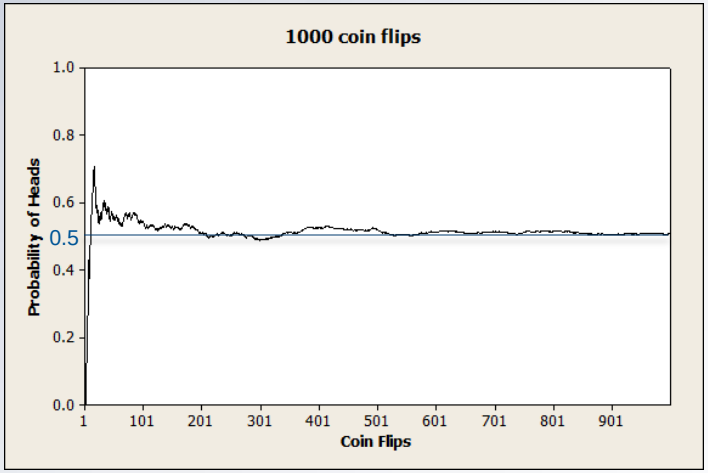
Variable	N	Mean	Minimum	Q1	Median	Q3	Maximum
C1	200	4.000	0.000	3.000	4.000	5.000	9.000

Grade 7

- Focus shifts to production of data: random sampling and making inferences

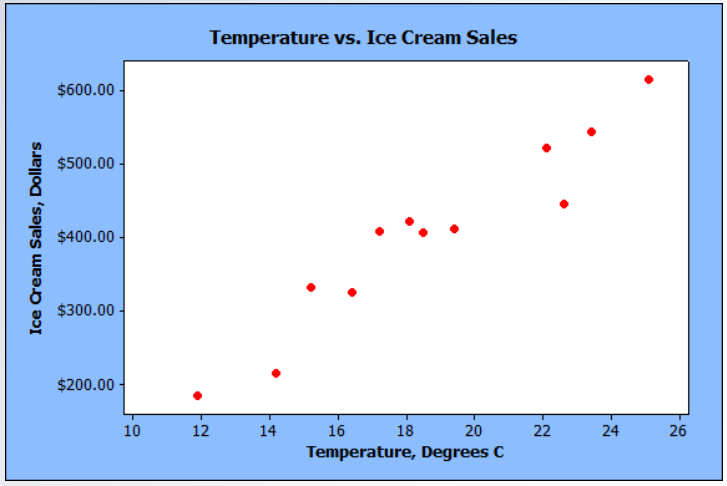


- Investigating probability as long-run relative frequencies
- Observe connections between theoretical and empirical models



Grade 8

- Bivariate Quantitative Data
  - Scatter Plots
  - Introduction to Linear Regression
- Bivariate Categorical Data
  - Two-way tables
  - (Segmented Bar Graphs)



Do eighth-grade students at this school prefer chocolate chip cookies or peanut butter cookies?

	Girls	Boys	Total
Chocolate Chip	25	40	65
Peanut Butter	32	23	55
Total	57	63	120

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High School

- Standard deviation is introduced to expand upon students' abilities to describe and compare data distributions
- Knowledge of probability is expanded to include conditional probability and independence
- Students move beyond analyzing data to making sound statistical decisions based on probability models
- Students understand that probability is enmeshed with data analysis and use that knowledge to make inferences on data collected from surveys and experiments.

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Activity – Matching Standards

Statistics and Probability Domain VERBS

Approximate
Assess
Construct
Develop
Design
Infer
Display
Interpret
Describe
Know
Recognize
Relate
Report
Summarize
Understand

For the following slides, match the activity with the standard, or standards, that apply from the Math Common Core Statistics and Probability Domain.

Four-Step Statistical Process

1. Formulate a question that can answered by data.
2. Design and implement a plan to collect appropriate data.
3. Analyze the collected data by graphical and numerical methods.
4. Interpret the analysis in the context of the original question.

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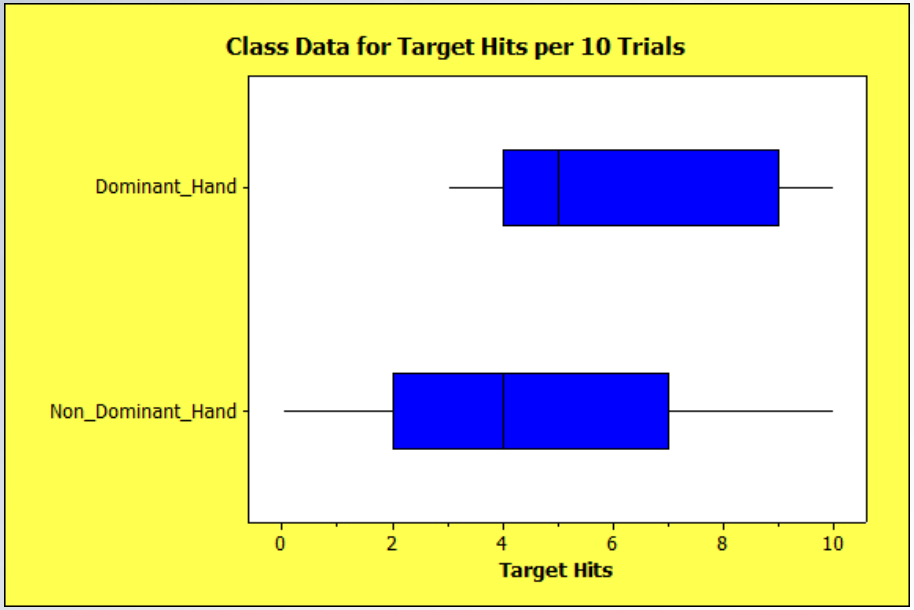
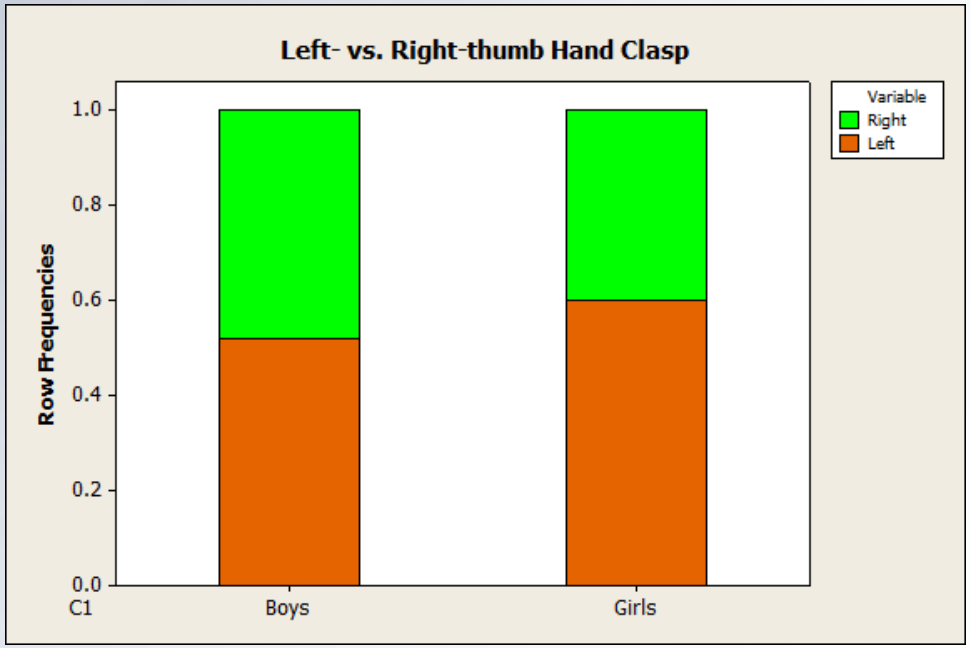
Activity #1

Students throw a spongy ball at a target 10 times with both their dominant hand and non-dominant hand. Results of data for a class of 25 are shown in the boxplots to the right. Decide whether students are “better” at hitting the target with their dominant hand or non-dominant hand. Justify your decision.



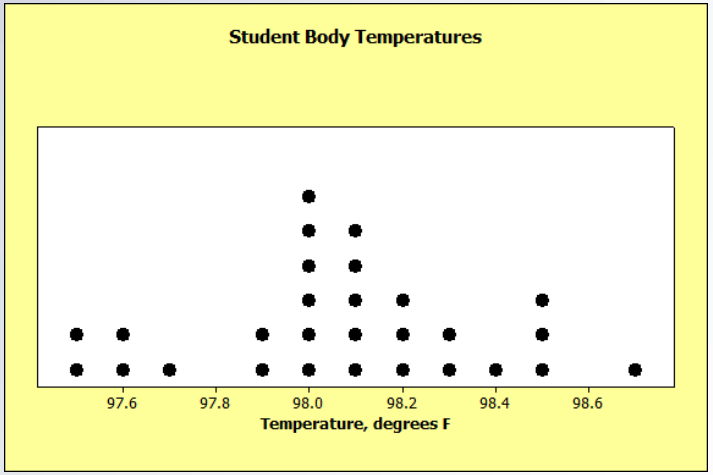
Activity #2

Students will investigate whether there is an association between gender and the genetic trait of ***hand clasping.*** (The dominant phenotype is placing the left thumb on top of the right.) Formulate a statistical question, collect data, organize in a two-way table, and interpret the results.



Activity #3

Is the “normal” human body temperature really 98.6°F? Students will investigate this question by collecting data for their class on body temperatures using disposable student thermometers and will summarize and describe the distribution of data using numeric summaries and graphic displays.



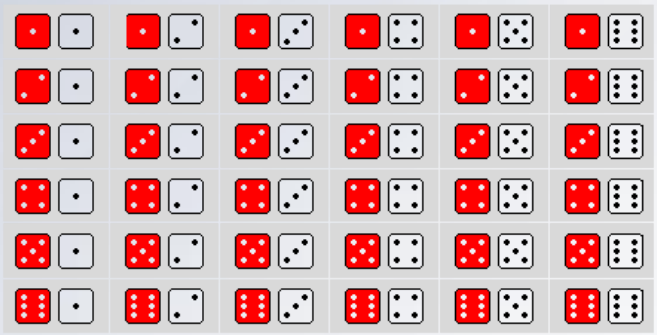
Variable	Mean	Median	Range	IQR
TEMP	98.071	98.100	1.200	0.350

Activity #4

2	3	4	5	6	7	8	9	10	11	12

Students will play a game using a number strip with values from 2 - 12 and 10 counters. Students will roll two dice and remove a counter with that sum. The first to remove all the counters will win. Then, students will investigate the probabilities of rolling two dice and getting various sums by listing the sample space and identifying the outcomes in the sample space. They will use this knowledge to adjust their game strategy.

Sample Space of the Rolling of 2 Dice



http://www.frontiernet.net/~rhode/QingTheory.html

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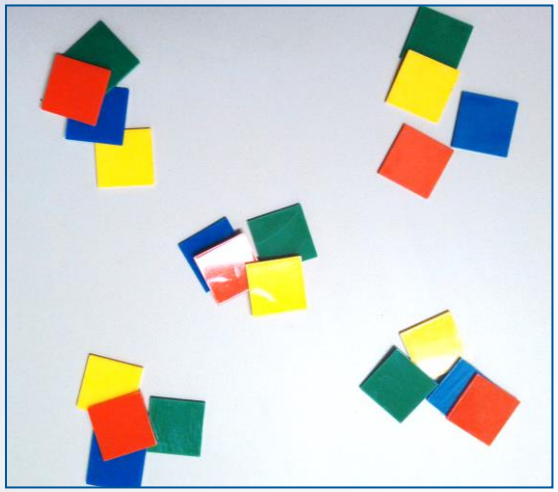
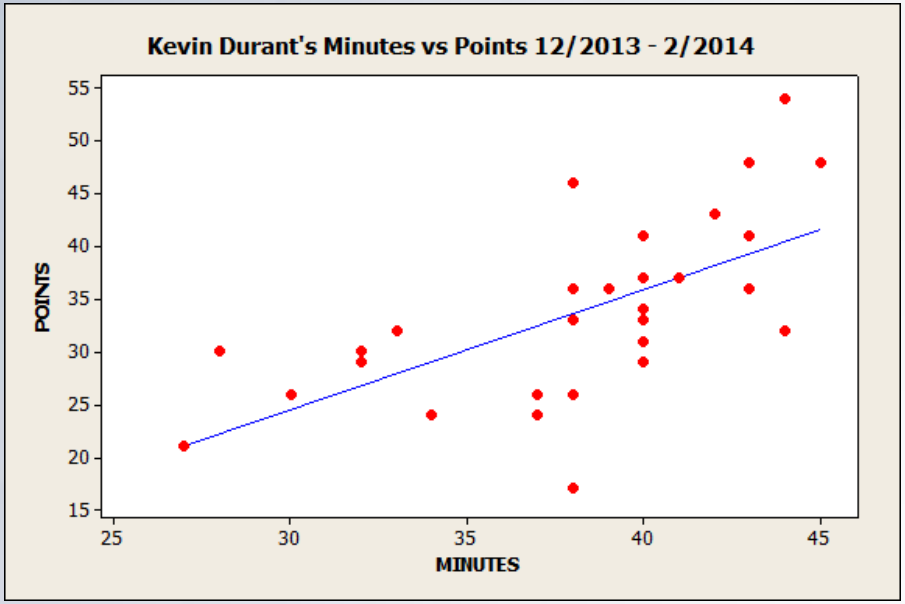
Activity #5

There are four different secret decoder gadgets (red, yellow, green, blue) that are offered in specially marked boxes of cereal. Unfortunately, only one gadget is in an individual box. What is the probability that at least five boxes of cereal would have to be purchased to get all four gadgets?



Activity #6

Students will investigate whether there is an association between the number of points their favorite NBA player scores in a game and the number of minutes played in the game. Students will describe the nature of the association, and model the association with a linear equation if appropriate.



The regression equation is
POINTS = - 9.6 + 1.14 MINUTES

Lessons in the Statistics and Probability Domain offer many opportunities to design through the lens of the Practice Standards

CC Math Practice Standards

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look at and express regularity in repeated reasoning

Statistical Questions

6th - Grade Lesson (see Lesson Plan notes in booklet)

The objectives of this lesson are to:

- Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. **CCSS.Math.Content.6.SP.1**
- Formulate questions that can be answered with data and make sense of practical problems by turning them into statistical investigations. **CCSS.Math.Practice.MP1**
- Interpret variability in terms of the question being asked. **CCSS.Math.Practice.MP2**

On a sentence strip:

Write one question that you would like to ask members of this class.

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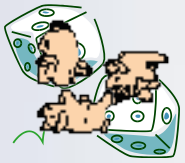
Pig Dice and Probability



7th - Grade Lesson (see Lesson Plan notes in booklet)

The objectives of this lesson are to:

- Develop a probability model for a fair die and use it to find probabilities of events related to rolling a fair die. Then, compare the model to the results of an experiment and explain the possible sources of the discrepancy **CCSS.Math.Content.7.SP.7 CCSS.Math.Practice.2 CCSS.Math.Practice.4**
- Approximate the probability of a chance event of rolling a pig die and obtaining a specific result by observing frequencies in the data. Also, explore the idea of probability as long-run relative frequencies. **CCSS.Math.Content.7.SP.6 CCSS.Math.Content.7.SP.7 CCSS.Math.Practice.5**
- Summarize and describe the distributions of rolls of the standard die and pig die. **CCSS.Math.Content.6.SP.4 CCSS.Math.Content.6.SP.5 CCSS.Math.Practice.6**

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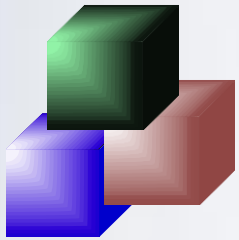
Sampling Using Centimeter Cubes



7th - Grade Lesson (see Lesson Plan notes in booklet)

The objectives of this lesson are to:

- Model a population of survey results using manipulatives. **CCSS.Math.Practice.MP.4**
- Examine a random sample of the population to generate an estimate of a typical, or "average" response to the question by the population. **CCSS.Math.Content.7.SP.1** **CCSS.Math.Practice.MP.2**
- Summarize and describe the distribution of the obtained sample in context. **CCSS.Math.Content.6.SP.5**
- Explore sampling variability by taking multiple samples using simulation involving linking cubes. **CCSS.Math.Content.7.SP.2**
- Reason through the impact that increasing the sample size has on the sampling variability. **CCSS.Math.Content.7.SP.2**
- Use statistical evidence to construct an argument for/against a position. **CCSS.Math.Practice.MP.3**

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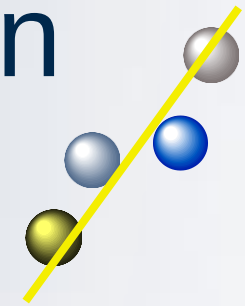
Introduction to Association in Bivariate Data



8th - Grade Lesson (see Lesson Plan notes in booklet)

What can you do with M&Ms and spaghetti?

The objectives of this lesson are to:

- Describe patterns of association between two quantities and determine the strength, type, and direction of the association. **CCSS.Math.Content.8.SP.1**
- Informally fit a line to the quantities and model the trend line mathematically. **CCSS.Math.Content.8.SP.2**
- Interpret the connection between the strength of the association and the use of the model for prediction. **CCSS.Math.Content.8.SP.2 CCSS.Math.Practice.MP3**
- Research two quantities which may exhibit either a positive or a negative association and describe graphically and mathematically. **CCSS.Math.Content.8.SP.3 CCSS.Math.Content.8.SP.2 CCSS.Math.Practice.MP4**

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Statistics Across the Curriculum

- Statistics provides opportunities to integrate with the social sciences
  - Comparing annual salaries for men and women in similar jobs
  - Investigating the likelihood of a particular candidate to win the election
- Many connections between statistics and science
  - Statistical problem-solving process is similar to the scientific method employed in inquiry models
  - Similarities in designing statistical studies and experimental design

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All the standards require that teachers focus more attention on the practices

- E5: Read, write, and speak grounded in evidence
- M3 & E4: Construct viable arguments and critique the reasoning of others
- S7: Engage in evidence from argument

Students must be provided with tasks and activities that allow them to engage in productive dialogue and work collaboratively.

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Common Core Mathematics, ELA and NGSS

"All students' mathematical learning will embody the concept that engagement in mathematics is essential, and that decision-making, risk-taking, cooperative work, perseverance, self-assessment, and self-confidence are frequently keys to success."

- *Mathematics Standards* Task Force

Big Ideas for lesson design

- Distributions describe variability in data.
- Statistics can be used to compare two or more groups of data.
- Bivariate distributions describe patterns or trends in the covariability in data on two variables.
- Inferential statistics uses data in a sample selected from a population to describe features of the population.

Source: *Developing Essential Understandings of Statistics for Teaching Mathematics in Grades 6-8*

EngageNY: A comprehensive middle school listing of lesson plans, instructional videos, and links to successfully implement the CCSS *http://schools.nyc.gov/Academics/CommonCoreLibrary/CommonCoreClassroom/Mathematics/middle_math*

Learn Zillion: At Learn Zillion you can explore math video lessons from grades 3-9. Search by Common Core domain, topic, or grade. *http://learnzillion.com/lessons*

Illustrative Mathematics: This website provides examples illustrating the range and types of mathematical work that students experience in a faithful implementation of the Common Core State Standards *http://www.illustrativemathematics.org/standards/k8*

The Mathematics Assessment Program (MAP) aims to bring to life the Common Core State Standards (CCSSM) in a way that will help teachers and their students turn their aspirations for achieving them into classroom realities. *http://www.map.mathshell.org/materials/index.php*

Comprehensive Illinois Resource List: *http://www.neoga.k12.il.us/vimages/shared/vnews/stories/50a2a5ac7056c/mathwebsites.pdf*

Internet Resources

Franklin, C., Kader, G., Mewborn, D., Moreno, J., Peck, R., Perry, M., & Schaeffer, R. (2007). *Guidelines for assessment and instruction in statistics education (gaise) report*. Alexandria, VA: American Statistical Association. DOI: www.amstat.org/education/gaise

Kader, G., Jacobbe, T., Wilson, P., & Zbiek, R. M. (2013). *Developing essential understanding of statistics for teaching mathematics in grades 6 - 8* . (1st ed.). National Council of Teachers of Mathematics.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. Washington, DC: Authors.

The Common Core Standards Writing Team. (2011, December 26). *Progressions for the common core state standards in mathematics*. Retrieved from http://commoncoretools.me/wp-content/uploads/2011/12/ccss_progression_sp_68_2011_12_26_bis.pdf

THANK YOU!!