Probability and Statistics - Unit 3 Statistics for Describing, Exploring, and Comparing Data	20 - 25 Days Established 14-15 Revised 20-21 Revised Nov 2021

Standard: NJSLS: S.ID and S.IC
Statistics for Describing, Exploring, and Comparing Data

Strand:
S-ID: Interpreting Categorical and Quantitative Data
Summarize, represent, and interpret data on a single count or measurement variable.

1. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
2. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers.)

S-IC: Making Inferences and Justifying Conclusions
Understand and evaluate random process underlying statistical experiments.

3. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

1. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
6. Evaluate reports based on data.

Curriculum aligned with: 2009 New Jersey Core Curriculum Content Standards for 21st Century Skills (9.1 A-F)

21st Century Theme: *Global Awareness ☐, Financial, economic, business and entrepreneurial literacy , ☐, Civic literacy ☐, Health literacy ☐ Environmental Literacy ,*

21st Century Skills: *Critical Thinking & Problem Solving , Creativity and Innovation ☐, Collaboration, Teamwork and Leadership ☐, Cross-Cultural Understanding and Interpersonal Communications ☐, Communication and Media Fluency ☐, Accountability, Productivity and Ethics ☐*

Interdisciplinary Connection: Math=MA, English=ELA, Science=SCI, Social Studies=SS, Physical Education=PE, Art=ART, Music=MU, Technology=TECH, World Language=WL, Business = BU

Essential Questions	Enduring Understandings	Activities, Investigation, and Student Experiences

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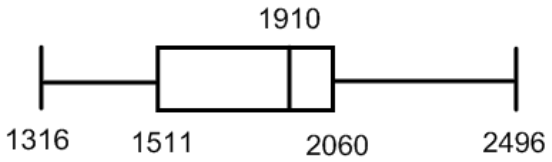
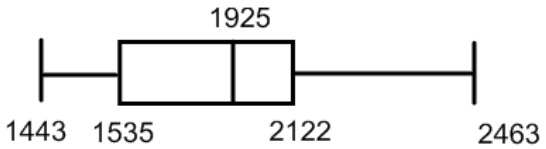
1. What are real life applications involving measures of center and variation? 2. How do we understand data? 3. How do we communicate data?	*Students will understand…* ● Measures of center consist of the mean, median, mode and midrange. They represent the central value of a data set. ● The mean is usually reliable however it is greatly affected by outliers; when outliers exist; the median is a better representation of the measure of center for the data set. ● The mean of a population is represented with μ. The mean of a sample is represented by $\bar{x}$.	***Task 1:*** **Interdisciplinary ELA** Statistics are sometimes used to compare or identify authors of different works. The lengths of the first 20 words in the foreword written by Tennessee Williams in *Cat on a Hot Tin Roof* are listed along with the first 20 words in *The Cat in the Hat* by Dr. Seuss. *Cat on a Hot Tin Roof:* 2 6 2 2 1 4 4 2 4 2 3 8 4 2 2 7 7 2 3 11 *The Cat in the Hat:* 3 3 3 3 5 2 3 3 3 2 4 2 2 3 2 3 5 3 4 4 ● Find the mean and median for each of the two samples, then compare the two sets of results. Does there appear to be a difference? ● Calculate the range, variance, and standard deviation. Does there appear to be a difference in variation? ***Answer:*** ● The mean of *Cat on a Hot Tin Roof* is 3.9 and the median is 3.0. For *The Cat in the Hat* the mean is 3.1 and the median is 3.0. These values can be found by entering the data into lists in the TI-83 or TI-84 and then selecting one variable statistics for each list. The mean and median values will appear. Based on the means, words in the first book appear to be longer than those in the second book. ● For *Cat on a Hot Tin Roof* the range is 10.0, the variance is 6.8 and the standard deviation si 2.6. For *The Cat in the Hat* the range is 3.0, the variance is 0.8 and the standard deviation is 0.9. These values can be found by entering the data into lists in the TI-83 or TI-84 and then selecting one variable statistics for each list. There is much less variation among the word lengths in *The Cat in the Hat*. ***Task 2:*** Stanford Binet IQ scores have a mean of 100 and a standard deviation of 16. Albert Einstein reportedly had an IQ of 160. ● What is the difference between Einstein's IQ and the mean? ● How many standard deviations is that [the difference found in part (a)]? ● Convert Einstein's IQ score to a *z* score.

	• If the distribution of data is not symmetric then it is said to be skewed. • When the data is negatively skewed or skewed left, the mean and median are to the left of the mode. • When the data is positively skewed or skewed right, then the mean and median are to the right of the mode. • Measures of variation consist of range, variance, and standard deviation. • The standard deviation represents the measure of	• If we consider "usual" IQ scores to be those that convert to z scores between -2 and 2, is Einstein's IQ usual or unusual? ***Answer:*** • 160-100 = 60. • 60/16 = 3.75. • $z = \frac{x-\mu}{\sigma} = \frac{160-100}{16} = 3.75$ • It is unusual because it is more than 2 standard deviations below the mean. ****Task 3:*** **Interdisciplinary SCI** In 1908, William Gosset published the article "The Probable Error of a Mean" under the pseudonym of "Student". He included the data listed below for two different types of corn seed (regular and kiln dried) that were used on adjacent plots of land. The listed values are the yields of head corn in pounds per acre. *Regular:* 1903 1935 1910 2496 2108 1961 2060 1444 1612 1316 1511 *Kiln Dried:* 2009 1915 2011 2463 2180 1925 2122 1482 1542 1443 1535 • Using the yields, find the 5 number summary and construct a boxplot for regular seed. • Using the yields, find the 5 number summary and construct a boxplot for kiln dried seed. • Do the results appear to be substantially different between the two boxplots? ***Answer:*** •

	variation of values about the mean. The variance is the square of the standard deviation. ● The range rule of thumb allows for unusual values to be identified. If a value is within two standard deviations of the mean it is considered to be usual. ● The empirical rule is used for data that is approximately normally distributed. According to the rule, about 68% of all of the values lie within one standard deviation of the mean; 95% of all	 ●  The results do not appear to be dramatically different. **Modifications and/or Accommodations:** ● **Special Education:** Utilize a multi-sensory (VAKT) approach during instruction, provide alternate presentations of skills by varying the method (repetition, simple explanations, additional examples, modeling, etc.), modify test content and/or format, allow students to retake test for additional credit, provide additional times and preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks. ● **English Language Learners:** Extend time requirements, preferred seating, positive reinforcement, check often for understanding/review, oral/visual directions/prompts when necessary, supplemental materials including use of online bilingual dictionary, and modified assessment and/or rubric. ● **Students at Risk of School Failure:** Deliver instruction utilizing varied learning styles including audio, visual, and tactile/kinesthetic, provide individual instruction as needed, modify assessments and/or rubrics, repeat instructions as needed. ● **Gifted Students:** Create an enhanced set of introductory activities, integrate active teaching/learning opportunities, incorporate authentic components, propose interest-based extension activities, and connect student to related talent development opportunities.

	values lie within two standard deviations of the mean; and 99.7% of all data values live within three standard deviations of the mean. ● Chebyshev's theorem can be applied to any data set. It states that at least 75% of the data lies within 2 standard deviations of the mean and at least 89% lies within 3 standard deviations of the mean. ● A *z* score represents the number of standard deviations a value is above or below the mean.	**Teacher Resources** online achievethecore resource online learnzillion resource online khanacademy resource online desmos resource online ixl resource

	● When a *z* score is negative, the corresponding data value exists below the mean. When a *z* score is positive, the corresponding data value exists above the mean. ● Ordinary values exist between 2 standard deviations above or below the mean. ● Quartiles divide the distribution into four groups; the median is the same as the second quartile. ● Percentiles divide the data set into 100 equal groups. ● Exploratory data analysis is the process of using statistical tools to	

	investigate data sets in order to understand their important characteristics. ● Outliers can be identified as values that are above the third quartile by an amount greater than 1.5 times the interquartile range or a is below the first quartile by an amount greater than 1.5 times the interquartile range. ● The interquartile range is calculated by taking the difference between the third and first quartiles. ● An outlier can have a dramatic	

	effect on the mean, standard deviation, and on the scale of the histogram. ● A boxplot is a graph that represents the five number summary which consists of the minimum value, the first quartile, the median, the third quartile and the maximum value. ● A modified boxplot is a boxplot that is constructed so that outliers are identified with a special symbol and the solid horizontal line extends only as far as the minimum data value that is not	

	an outlier and the maximum value that is not an outlier.	
Content Statements	**Cumulative Progress Indicators**	
Students will know… ● How to calculate mean, median, mode and midrange ● How to calculate standard deviation, variance, and range ● How to use the range rule of thumb to understand standard deviation ● How to use the empirical rule with a normal distribution ● How Chebyshev's Theorem applies to any data set but has limited usefulness ● How to use coefficient of variation to understand standard deviations from different data sets	● Tests ● Quizzes ● Practice problems for homework ● Workbook pages ● Worksheets	

- How z scores can be used to compare values from different data sets or to compare values within the same data set
- How to calculate percentiles and quartiles
- How to use the five number summary to construct a boxplot

Desired Results

- **Mean, Median, and Mode**
- **Range**
- **Chebyshev's Theorem**
- **Z scores**
- **Percentiles and Quartiles**
- **Constructing boxplots**

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**

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5. Use appropriate tools strategically. **6. Attend to precision.** **7. Look for and make use of structure.**	
Standards for Mathematical Practices	
8. Look for and express regularity in repeated reasoning.	

LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*

Neil Devine - American Stellar and planetary astrophysicist whose work centered on the understanding of star formation.

The mission is to ensure that every student is able to see themselves in our rich and diverse history.

Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***
Self-Awareness Social Awareness Self-Management Relationship Skills Responsible Decision-Making	• Recognizing the importance of self-confidence in handling daily tasks and challenges. • Demonstrate an awareness of the expectations for social interactions in a variety of ways. • Demonstrate an understanding of the need for mutual respect when viewpoints differ. • Recognize the skills needed to establish and achieve personal and educational goals. • Utilize positive communication and social skills to interact effectively with others. • Develop, implement, and model effective problem solving and critical thinking skills.

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