Intro to Statistics and Probability

Content Area: **Math**
Course(s):
Time Period: **MP4**
Length: **45**
Status: **Published**

Unit Overview

Unit Summary	Unit Rationale
In this unit on statistics and probability, students will explore the fundamental concepts and techniques used to analyze and interpret data. They will begin by understanding various measures of central tendency, including mean, median, and mode, and learn how to calculate and apply them in different contexts. Students will also delve into measures of variability, such as range, interquartile range, and standard deviation, to understand data dispersion. The unit will cover different data distributions and their shapes, highlighting the importance of recognizing whether data is usually distributed, skewed, or follows another pattern. Students will learn about probability principles, including calculating probabilities for independent and dependent events and distinguishing between permutations and combinations. Additionally, they will explore the concept of random sampling and understand its significance in obtaining representative data. The unit will address common misconceptions, such as the difference between correlation and causation and the importance of precise mathematical calculations in probability. Students will engage in critical thinking and logical reasoning throughout the unit, applying their skills to real-world data and scenarios. By the end of the unit, students will have a solid foundation in statistics and probability, enabling them to analyze data accurately and make informed decisions based on their findings.	The rationale for this unit on statistics and probability is grounded in the critical role these concepts play in both academic and real-world contexts. Understanding statistics and probability equips students with the tools to analyze and interpret data, make informed decisions, and critically evaluate information in everyday life. Most of these students are college-bound and will eventually take some research classes. It is important to introduce the students to these concepts before heading out after high school. In an era where data-driven decision-making is paramount across various fields such as science, business, healthcare, and public policy, a solid foundation in these areas is essential. This unit aims to develop students' quantitative literacy, enabling them to navigate and understand the increasingly data-saturated world around them. The unit fosters analytical thinking and problem-solving skills by addressing common misconceptions and providing hands-on experience with real-world data. Ultimately, this knowledge empowers students to become informed citizens and competent professionals capable of making evidence-based decisions and contributing meaningfully to society.

NJSLS

MATH.9-12.S.ID.A.2	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.

MATH.9-12.S.ID.A.4	Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.
MATH.9-12.N.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MATH.9-12.S.IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
MATH.9-12.S.IC.A.2	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
MATH.9-12.S.IC.B.3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
MATH.9-12.S.IC.B.4	Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
MATH.9-12.S.IC.B.5	Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
MATH.9-12.S.IC.B.6	Evaluate reports based on data (e.g., interrogate study design, data sources, randomization, the way the data are analyzed and displayed, inferences drawn and methods used; identify and explain misleading uses of data; recognize when arguments based on data are flawed).
MATH.9-12.S.CP.A.1	Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).
MATH.9-12.S.CP.A.2	Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
MATH.9-12.S.CP.A.3	Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
MATH.9-12.S.CP.A.4	Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.
MATH.9-12.S.CP.A.5	Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
MATH.9-12.S.CP.B.6	Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model.
MATH.9-12.S.CP.B.7	Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.
MATH.9-12.S.CP.B.8	Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B \mid A) = P(B)P(A \mid B)$, and interpret the answer in terms of the model.
MATH.9-12.S.CP.B.9	Use permutations and combinations to compute probabilities of compound events and solve problems.
MATH.9-12.S.MD.A.1	Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.
MATH.9-12.S.MD.A.3	Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value.
MATH.9-12.S.MD.A.4	Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value.

Standards for Mathematical Practice

MATH.K-12.1	Make sense of problems and persevere in solving them
MATH.K-12.2	Reason abstractly and quantitatively
MATH.K-12.3	Construct viable arguments and critique the reasoning of others
MATH.K-12.4	Model with mathematics
MATH.K-12.5	Use appropriate tools strategically
MATH.K-12.6	Attend to precision
MATH.K-12.7	Look for and make use of structure
MATH.K-12.8	Look for and express regularity in repeated reasoning

Unit Focus

Enduring Understandings	Essential Questions
• A statistical question is a question that can be answered by collecting many pieces of information, or data. • The way in which samples are chosen for a study effects how well they represent the population. To avoid bias, samples should be random. • A data distribution can be normal, skewed left, or skewed right. Normal distributions are described using the mean and standard deviation. For skewed distributions, median and quartiles are used to describe the data. • The normal distribution is used to explain where data values fall within a population. The standard normal distribution allows for a comparison of values across different population distributions. • Sample statistics tend to be normally distributed and therefore can be used to estimate population parameters. • A hypothesis and a null hypothesis can be written and tested for a statistical question. statistics are used to compare two data groups and determine which hypothesis the data supports. • Two events are independent if the occurrence	• What makes a question a statistical question? • How does the method of sample selection impact the results of a study? • How can data distributions be classified? • How is the normal distribution used to explain data values within a population? • How can sample statistics be used to estimate population parameters? • What are the steps to formulate and test a hypothesis and a null hypothesis? • What are mutually exclusive events and how do they differ from independent events? • How do we determine if two events are independent using conditional probability? • What is the difference between permutations and combinations? • How do we define a theoretical probability distribution?

of one does not affect the probability of the other. The probability that two independent events both occur is the product of their probabilities. • The conditional probability that event A will occur, given that another event B has occurred is written as P(A|B) and can be calculated by dividing P(A and B) by P(B). Two events are independent if and only if P(A| B) = P(A) and P(B|A) = P(B). • A permutation is an arrangement of items in which the order of the items matters, while a combination is an arrangement in which order does not matter. • You can define a theoretical probability distribution by calculating the probability of each outcome in an experiment or an experimental probability distribution by using the real world relative frequency of each outcome.	

Instructional Focus

Learning Targets

- Define and recognize a statistical question.
- Define an identify the type of statistical variable that is represented by a question or the data represented on a graph.
- Distinguish between quantities such as population/sample and parameter/statistic for the purpose of descriptive modeling.
- Identify experiments, sample surveys, and observational studies.
- Recognize bias in sampling methods.
- Identify a sampling method that provides a random sample from a population.
- Find measures of center and spread, such as median, mean, interquartile range, and standard deviation.

- Compare data sets using statistical measures that are appropriate for the distribution of the data.
- Fit a normal distribution to data.
- Compare and evaluate data values using z-scores.
- Use technology to calculate the area under the standard normal distribution curve.
- Evaluate reports by estimating population parameters.
- Use multiple samples to make an inference about a population.
- Calculate the margin of error for quantitative or categorical data.
- Formulate two hypotheses for a statistical question and test using statistics to draw a conclusion.
- Use graphs and simulation to determine whether differences between parameters are significant.
- Use data from a randomized experiment to evaluate a report.
- Explain independence of events in everyday language and everyday situations.
- Determine the probability of the union of two events (A or B) and the intersection of two independent events (A and B).
- Understand the conditional probability of A given B as the fraction of outcomes in B that also belong to A.
- Interpret independence of events in terms of conditional probability.
- Use a two-way frequency table to decide if events are independent and to approximate conditional probabilities.
- Calculate the number of permutations and combinations in mathematical and real world contexts.
- Use permutations and combinations to compute probabilities of compound events and solve problems.
- Develop a probability distribution based on theoretical probabilities or empirical data.
- Graph probability distributions.
- Calculate probability in binomial experiments.

Prerequisite Skills

- Ability to perform operations with whole numbers, fractions, decimals, and percentages.
- Understanding of basic algebraic concepts such as variables, expressions, and equations.
- Ability to read and interpret various types of graphs, including bar graphs, line graphs, and

histograms.

- Understanding of how to plot points on a Cartesian coordinate system.
- Familiarity with creating and interpreting tables of data.
- Understanding of measures of central tendency (mean, median, mode).
- Knowledge of measures of dispersion (range, interquartile range, variance, standard deviation).
- Understanding of basic probability principles, such as the probability of a single event occurring.
- Familiarity with concepts such as sample space, events, and outcomes.
- Ability to analyze and interpret data critically.
- Skills in making logical conclusions based on given data.
- Understanding of basic logic and reasoning processes.
- Knowledge of sets, subsets, and Venn diagrams.
- Understanding of set operations such as union, intersection, and complement.
- Basic skills in using calculators for statistical calculations.
- Ability to clearly communicate mathematical reasoning and interpretations of data.
- Skills in writing concise explanations and justifications for conclusions drawn from data analysis.
- Basic knowledge of different sampling methods (random sampling, stratified sampling, etc.).
- Understanding of the importance of unbiased sampling in statistical studies.

Common Misconceptions

- Students may think all averages are the same.
- Some students believe mean is always the best measure of central tendency.
- Some students believe the range is a reliable measure of variability.
- Students may think all data distributions are normal (bell-shaped).
- Some students believe correlation implies causation.
- Some students believe larger samples always lead to more accurate results.
- Students may think probability is intuitive and doesn't require precise calculation.
- Some students believe mutually exclusive events are the same as independent events.

- Some students believe random sampling means any method of choosing samples.
- Students may think the margin of error is a fixed value.
- Some students believe hypothesis testing always proves the hypothesis.
- Some students believe conditional probability is the same as regular probability.
- Students may think permutations and combinations are interchangeable.
- Some students believe data collected from a survey always represents the population accurately.

Spiraling For Mastery

Current Unit Content/Skills	Spiral Focus	Activity
• Understand statistical questions • Understand statistical variables • Distinguish between Populations and Samples • Distinguish between parameters and statistics • Discuss different types of studies. • Determine sources of bias. • Identify sampling methods • Find measures of center and spread • Use appropriate statistics to compare data sets • Recognize a normal distribution • Classify a data distribution	• Students will need to apply their knowledge of basic arithmetic operations and algebraic skills to calculate measures of central tendency and variability. • Prior knowledge of various data representation methods, such as bar graphs, histograms, pie charts, and box plots, will be essential. • Understanding fractions, decimals, and percentages is vital when calculating probabilities, interpreting statistical results, and comparing data sets. • Previous units that emphasized logical reasoning and problem-solving skills will be important as students analyze data, evaluate statistical claims, and make informed decisions based	• iXL Diagnostic Assessment • iXL Problems • Delta Math

• Discuss the Emirical Rule • Find population intervals • Use the Emirical rule to solve problems • Compare values using z-scores. • Estimate population parameters • Make an inference using Multiple samples • Use a simulation to evaluate a claim. • Write hypotheses • Examine data from an experiment • Use simulation results to test hypotheses • Find probabilities of mutually exclusive events. • Identify independent events and find their probabilities • Understand conditional probability. • Use the test for independence • Use the Fundamental Counting Principle • Distinguish between a permutation and a combination. • Find permutations and combinations. • Use permucation and combinations to find	on probability and statistical principles. • Knowledge of independent and dependent variables, as well as the ability to identify relationships between variables, will be important when exploring correlation, causation, and conditional probability. • Any prior introduction to basic probability concepts will be built upon in this unit.	

probabilities. • Develop a theoretical probability distribution • Develop an experimental probability distribution • Binomial Experiments		

Assessment

Formative Assessment	Summative Assessment
• Homework • Lesson Checks • Quizzes • Exit Tickets • Lesson Reflections • Performance Tasks	Mid Unit Assessment - Statistics Benchmark 4 (Linkit)

Resources

Key Resources	Supplemental Resources
• EnVision Algebra 2, Chapters 11 and 12	iXL Delta Math Math Medic Desmos Activity Builder Khan Academy Teacher made Worksheets

Career Readiness, Life Literacies, and Key Skills

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.

Interdisciplinary Connections

ELA.RL.CR.11–12.1	Accurately cite strong and thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as interpretations of the text; this may include determining where the text leaves matters uncertain.
ELA.W.AW.11–12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
HE.9-12.2.1.12.PGD	Personal Growth and Development
HE.9-12.2.2.12.N	Nutrition
HE.9-12.2.2.12.PF	Physical Fitness
PFL.9.1.12.E.2	Analyze and apply multiple sources of financial information when prioritizing financial decisions.
SOC.6.1.16	Contemporary United States: Interconnected Global Society (1970–Today)
SOC.6.2.6	Contemporary Issues
SOC.6.3	Active Citizenship in the 21st Century
9-12.HS-ESS3	Earth and Human Activity
9-12.HS-LS2	Ecosystems: Interactions, Energy, and Dynamics
9-12.HS-PS1	Matter and Its Interactions