Probability and Statistics - Unit 8 Hypothesis Testing	Revised August 2023 Revised Nov 2021 20 - 25 Days

Standard – NJSLS: S.ID and S.IC
Hypothesis Testing

Strand
S-ID: Interpreting Categorical and Quantitative Data
Summarize, represent, and interpret data on a single count or measurement variable
1. *Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-IC: Making Inferences and Justifying Conclusions
Understand and evaluate random processes underlying statistical experiments.
1. 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.
2. 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.

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
1. What is the purpose of inferential statistics? 2. What are real life examples where the	*Students will understand…* ● A hypothesis test is a standard	***Task 1:*** Based on the given conditions, identify the alternative hypothesis. Identify the sampling distribution (normal or *t*) of the test statistic.

methods of hypothesis testing can be applied?	procedure for testing a claim about a property of a population. • The rare event rule for inferential statistics is used for testing a claim by analyzing sample data in an attempt to distinguish between results that can easily occur by chance and results that are highly unlikely to occur by chance. • The null hypothesis denoted by H_0 is a statement that the value of a population parameter is equal to some claimed value.	• Claim: The mean annual income of full-time college students is below $10,000. Sample data: For 750 randomly selected college students, the mean is $3662 and the standard deviation is $2996. The sample data suggest that the population has a distribution that is not normal. • Claim: The majority of college students have at least one credit card. Sample data: Of 500 randomly selected college students, 82% have at least one credit card. • Claim: The mean IQ of adults is equal to 100. Sample data: $n = 150$ and $\bar{x} = 98.8$. it is reasonable to assume that $\sigma = 15$. ***Answer:*** • $H_1 : \mu < \$10{,}000$; t distribution • $H_1 : p > 0.5$; normal distribution • $H_1 : \mu \neq 100$; normal distribution ***Task 2:*** **Interdisciplinary BU** *Glamour* magazine sponsored a survey of 25000 prospective brides and found that 60% of them spent less than $750 on their wedding gown. • Use a 0.01 significance level to test the claim that less than 62% of brides spend less than $750 on their wedding gown. • How are the results affected if it is learned that the responses were obtained from magazine readers who decided to respond to the survey through an Internet Web site? ***Answer:*** • $H_0 : p = 0.62$. $H_1 : p < 0.62$. Test statistic: $z = -2.06$. Critical value: $z = -2.33$. P-value: 0.0197. Fail to reject the H_0 . There is not sufficient evidence to support the claim that less than 62% of brides spend less than $750 on their wedding gown.

	• The alternative hypothesis denoted by H_1 is the statement that the population parameter has a value that somehow differs from the null hypothesis. • If you are conducting a study and want to use a hypothesis test to support your claim, the claim must be worded so that it becomes the alternative hypothesis. • The test statistics is a value used in making a decision about the null hypothesis. • The test statistic is found by	• The results would not be valid if they were obtained from a voluntary response sample. ***Task 3:*** **Interdisciplinary BU** The Carolina Tobacco Company advertised that its best-selling nonfiltered cigarettes contain at most 40 mg of nicotine, but *Consumer Advocate* magazine ran tests of 10 randomly selected cigarettes and found the amounts (in mg) shown in the accompanying list. It's a serious matter to charge that the company advertising is wrong, so the magazine editor chooses a significance level of $\alpha = 0.01$ in testing her belief that the mean nicotine content is greater than 40 mg. 47.3 39.3 40.3 38.3 46.3 43.3 42.3 49.3 40.3 46.3 Using a 0.01 significance level, test that editor's belief that the mean is greater than 40 mg ***Task 3 Answer:*** • $H_0 : \mu = 40$ mg. $H_1 : \mu > 40$ mg. Test statistic: $t = 2.746$. Critical value: $t = 2.821$. P-value: greater than 0.0113. Fail to reject H_0. There is not sufficient evidence to support the claim that the mean body nicotine content is greater than 40 mg. **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

	converting the sample statistic to a score with the assumption that the null hypothesis is true. ● The critical region is the set of all values of the test statistic that cause use to reject to the null hypothesis. ● The significance level is the probability that the test statistic will fall in the critical region when the null hypothesis is actually true. ● A critical value is any value that separates the critical region from the values of the test statistic that do not lead to	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. **Spot Light On:** *Use random response strategies* **Teacher Resources** online achievethecore resource online learnzillion resource online khanacademy resource online desmos resource online ixl resource

	rejection of the null hypothesis. ● With hypothesis testing, your conclusion is either to reject the null hypothesis or fail to reject it. ● Type I error is the mistake of rejecting the null hypothesis when it is actually true. The alpha symbol (α) is used to represent the probability of a type I error. ● Type II error is the mistake of failing to reject the null hypothesis when it is actually false. The beta symbol (β) is used to represent the probability of a type II error.	

	• The power of a hypothesis test is the probability (1 - β) of supporting an alternative hypothesis that is true. • Claims about a population proportion are tested by using a normal distribution as an approximation to the binomial distribution. • To test claims about a population proportion, you must be sure the requirements are satisfied.	
Content Statements	**Cumulative Progress Indicators**	

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Students will know… ● How the fundamentals of hypothesis testing ● How to identify the null hypothesis and the alternative hypothesis if given a claim and express both in symbolic form. ● How calculate the value of the test statistic if given a claim and sample data ● How identify the critical values with a given significance level ● How to identify the *P*-value given a value of the test statistic ● How to state the conclusion of a hypothesis test in simple, nontechnical terms ● How to use a calculator to do hypothesis testing	● Tests ● Quizzes ● Practice problems for homework ● Workbook pages ● Worksheets	
Desired Results		
● **Hypothesis Testing** ● **Critical Values** ● **P-value** ● **Using a calculator for Hypothesis testing**		

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Standards for Mathematical Practices

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 for and express regularity in repeated reasoning.**

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

Stephen Hawking - Despite living with amyotrophic lateral sclerosis, Stephen Hawking is a world-renowned physicist who is credited with groundbreaking discoveries involving quantum theory and general relativity, among others.

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

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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.

New Jersey Legislative Statutes and Administrative Code (place an "X" before each law/statute if/when present within the curriculum map)									
	Amistad Law: *N.J.S.A. 18A 52:16A-88*		Holocaust Law: *N.J.S.A. 18A:35-28*	**x**	LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*	**x**	Diversity & Inclusion: *N.J.S.A. 18A:35-4.36a*		Standards in Action: *Climate Change*