# Unit 05: Inference for Categorical Data: Proportions

Content Area:
Course(s):
Time Period: **Year**
Length: **180**
Status: **Published**

## Unit 5

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| **Unit Title:** | Inference for Categorical Data: Proportions |
| **Suggested Duration:** | **3 weeks** |

## Interdisciplinary Connections

| Interdisciplinary Connections |
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| **Reading and Writing Companion Standards for History, Social Studies, Science and Technical Subjects**<br>▪ Grades 9-10<br>▪ Grades 11-12<br><br>**Math Practices**:<br>https://www.nj.gov/education/standards/math/Index.shtml<br><br>**Science Practices**:<br>https://www.nj.gov/education/standards/science/Index.shtml<br><br>Find and paste appropriate Companion Standards or Practices here. |

Real world Data will be used as part of each of the Learning Activities. Once the basic concepts and skills are Mastered, each activity and problem will use this knowledge and these skills to connect Mathematics to another discipline.

## Technology Integration

| Technology Integration |
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| Northern supports the integration of the SAMR Model: a framework which extends learning through the use of technology. The installation of interactive boards, the purchase of softwares and subscriptions, and the investment in 1:1 laptops and various other instructional technologies are examples of Northern's commitment to enhancing students' learning and preparing the 21st century learner for college and careers. |

Extensive use of TI-84, Stapplet, Google Classroom, AP Classroom, Desmos, and Khan Academy.

## Standard(s) Addressed

**Statistical Practices:**

1. Formulate Questions: Determine an investigative question for a statistical study.

2. Collect Data: Identify and justify methods for collecting data and conducting statistical inference.

3. Analyze Data: Construct representations of data and calculate numerical statistical outputs.

4. Interpret Results: Interpret results and justify conclusions and methods.

**Course Topics:**

3.3 Constructing a Confidence Interval for a Population Proportion

3.4 Justifying a Claim Based on a Confidence Interval for a Population Proportion

3.5 Setting Up a Test for a Population Proportion

3.6 p-Values

3.7 Carrying Out a Test for a Population Proportion

3.8 Potential Errors When Performing Tests

3.10 Constructing a Confidence Interval for the Difference Between Two Population Proportions

3.11 Justifying a Claim Based on a Confidence Interval for the Difference Between Two Population Proportions

3.12 Setting Up a Test for the Difference Between Two Population Proportions

3.13 Carrying Out a Test for the Difference Between Two Population Proportions

3.14 Setting Up a Chi-Square Test for Homogeneity or Independence

3.15 Carrying Out a Chi-Square Test for Homogeneity or Independence

4.2 Constructing a Confidence Interval for a Population Mean or Population Mean Difference

4.4 Setting Up a Test for a Population Mean or Population Mean Difference

## STAGE I Desired Results

<table>
<tr><th colspan="2">STAGE I Desired Results</th></tr>
<tr><td colspan="2">Objective (Transfer)</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…<br><br>This unit introduces statistical inference, which will continue through the end of the course. Students will analyze categorical data to make inferences about binomial population proportions. Provided conditions are met, students will use statistical inference to construct and interpret confidence intervals to estimate population proportions and perform significance tests to evaluate claims about population proportions. Students begin by learning inference procedures for one proportion and then examine inference methods for a difference between two proportions. They will also interpret the two types of errors that can be made in a significance test, their probabilities, and possible consequences in context.</td></tr>
<tr><td colspan="2">Mastery</td></tr>
<tr><td>Big Ideas/Understandings<br><br>Students will understand that…<br><br>BIG IDEA 1: VARIATION AND DISTRIBUTION (VAR)<br><br>The distribution of measures for individuals within a sample or population describes variation. The value of a statistic varies from sample to sample. How can we determine whether differences between measures represent random variation or meaningful distinctions? Statistical methods based on probabilistic reasoning provide the basis for shared understandings about variation and about the likelihood that variation between and among measures, samples, and populations is random or meaningful.<br><br>BIG IDEA 2: PATTERNS AND UNCERTAINTY (UNC)<br><br>Statistical tools allow us to represent and describe patterns in data and to classify departures from patterns. Simulation and probabilistic reasoning allow us to anticipate</td><td>Essential Questions<br><br>§ When can we use a normal distribution to perform inference calculations involving population proportions?<br><br>§ How can we narrow the width of a confidence interval?<br><br>§ If the proportion of subjects who experience serious side effects when taking a new drug is smaller than the proportion of subjects who experience serious side effects when taking a placebo, how can we determine if the difference is statistically significant?<br><br>§ How does increasing the degrees of freedom influence the shape of the chi-square distribution?<br><br>§ Why is it inappropriate to use statistical inference to justify a claim that there is no association between variables?</td></tr>
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| patterns in data and to determine the likelihood of errors in inference.<br><br>**BIG IDEA 3: DATA-BASED PREDICTIONS, DECISIONS, AND CONCLUSIONS (DAT)**<br><br>Data-based regression models describe relationships between variables and are a tool for making predictions for values of a response variable. Collecting data using random sampling or randomized experimental design means that findings may be generalized to the part of the population from which the selection was made. Statistical inference allows us to make data-based decisions. | |
| ***Acquisition*** | |
| *Students will know . . .*<br><br>See "essential knowledge" in each topic of College Board CED for Unit 6 | *Students will be skilled at . . .*<br><br>Unit 6 is a critical transition point in the course, as students begin learning skills that will be applied repeatedly in subsequent units. Students need to familiarize themselves with these procedures so they can build proficiency over time. Applying different inference methods requires fluency with verifying conditions. Students often check conditions superficially (e.g., just listing "SRS") without explicitly connecting them to the problem. Teachers can make sure students practice verifying conditions in context by providing numerical calculations and explaining how each condition is met. Precision of language is key.<br><br>Students often interpret confidence intervals and confidence levels incorrectly. Providing students with sentence starters or templates can help them learn to generate appropriate responses (e.g., Confidence interval: "We are 95% confident that the interval from to captures the [parameter in context]."). For decisions based on a hypothesis test, students may incorrectly |

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| | claim that “we can accept” or “have proven” the null.<br><br>Teachers can reinforce early and often that statistical tests do not provide evidence for what can be accepted or proved; they only provide evidence for “rejecting” or “failing to reject” the null<br><br>Students should continue applying the same problem-solving structure to chi-square significance testing: State the hypotheses in words, explicitly identify the correct procedure, verify conditions, calculate the test statistic and the p-value, and then draw a conclusion in context that is directly linked to the p-value.<br><br>Students should have opportunities to practice the distinctive elements for each type of chi-square test, such as analysis of expected counts, degrees of freedom, verbally stated hypotheses, and two-way tables. When the p-value is large, drawing an appropriate conclusion is challenging for students. Saying there is “no association” between two variables is equivalent to incorrectly “accepting the null hypothesis.” Instead, teachers can teach students to use nondeterministic language in their conclusions, that is, “The data do not provide strong enough evidence to conclude that the variables are associated.” Students should have frequent opportunities to practice writing, with detailed feedback to help them improve. |

## STAGE II Assessment Evidence

| STAGE II Assessment Evidence | |
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| Evaluations | Assessments |
| Evaluation following AP exam format (multiple choice + FRQ) on CED unit pulling from chapters 8, 9, and 10 of The Practice of Statistics | Formative assessments will be based on FRQs from previous AP exams on topics at regular intervals in the chapter/unit. |

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| Modifications |
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| How are the evaluations/assessments modified/accelerated? (i.e.: alternate assessment). All courses follow a balanced assessment system with Practice, Assessments, Evaluations. |

Modifications on 504 plans may be submitted at (SSD). prior to testing. Both exclusion statements and extensions exist for each standard to accommodate different paces.

## STAGE III Learning Plan

| STAGE III Learning Plan |
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| **Organize plan by weeks** |

Part 1: Confidence Intervals for Proportions
Day 1: What is a Confidence Interval?
Day 2: What is a Confidence Level?
Day 3: Quiz
Day 4: Confidence Intervals for Proportions
Day 5: The Four Step Process for Confidence Intervals
Day 6: Quiz
Day 7: Confidence Intervals for a Difference in Proportions
Day 8: Review
Day 9: Chapter Test
Part 2: Significance Tests for Proportions
Day 1: Introduction to Significance Tests
Day 2: What is a Significance Test?
Day 3: Significance Tests about a Proportion
Day 4: The Four Step Process for Significance Tests
Day 5: Quiz
Day 6: Significance Tests about a Difference in Proportions
Day 7: The Four Step Process for Significance Tests for a Difference in Proportions
Day 8: Quiz

Day 9: Type 1 and Type 2 Error
Day 10: Power
Day 11: Review
Day 12: Chapter Test

from old unit 8/chapter 12:

Day 4: Lesson 11.2 -Chi-Square Test for Homogeneity
Day 5: Lesson 11.2 - Chi-Square Test for Independence

| Modifications |
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| **How are the activities modified/differentiated? (i.e.: abridged text)** |

Modifications on 504 plans may be submitted at (SSD). prior to testing. Both exclusion statements and extensions exist for each standard to accommodate different paces.

## Specific Resources for Unit

| Specific Resources for Unit |
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| **Attached Affirmative Action Compliance Checklist** |

Lesson Plans for CED Unit 6: Inference for Proportions
LP: AP Chapter 8 | StatsMedic
LP: AP Chapter 9 | StatsMedic
LP: AP Chapter 10 | StatsMedic
Confidence intervals | AP®□ Statistics | Math
Significance tests (hypothesis testing) | AP®□ Statistics
Unit: Inference comparing two groups or populations
AP Classroom

LP: AP Chapter 11 | StatsMedic
Chi-square tests for categorical data | AP®□ Statistics
AP Classroom

## Diversity, Equity, & Inclusion

| Diversity, Equity &Inclusion |
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| Provide a brief description of how this unit addresses DE&I. |

## Career Readiness (9.2), Life Literacies and Key Skills (9.4) Standards

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| WRK.K-12.P.1 | Act as a responsible and contributing community members and employee. |
| WRK.K-12.P.2 | Attend to financial well-being. |
| WRK.K-12.P.3 | Consider the environmental, social and economic impacts of decisions. |
| WRK.K-12.P.4 | Demonstrate creativity and innovation. |
| WRK.K-12.P.5 | Utilize critical thinking to make sense of problems and persevere in solving them. |
| WRK.K-12.P.6 | Model integrity, ethical leadership and effective management. |
| WRK.K-12.P.7 | Plan education and career paths aligned to personal goals. |
| WRK.K-12.P.8 | Use technology to enhance productivity increase collaboration and communicate effectively. |
| WRK.K-12.P.9 | Work productively in teams while using cultural/global competence. |

## Climate Change Education

| ClimateChange Education | |
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| Enduring Understandings/Core Ideas | Performance Expectations |
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| Math and ELA- Provide a brief description of a lesson or activity that relates to Climate Change. All other Content Team copy and paste the Core Idea and Performance Expectation from NJDOE link above. | |