Unit 4: Inferences for Categorical and Quantitative Data

Content Area: **Mathematics**
Course(s): **Traditional Statistics**
Time Period: **March**
Length: **~13 weeks**
Status: **Published**

Unit Overview:

This unit introduces statistical inference, which will continue through the end of the course. Students will start off with analyzing 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, perform significance tests to evaluate claims about population proportions, their probabilities, and possible consequences in context.

Next, students will analyze quantitative data to make inferences about population means. Students should understand that t ∗ and t-tests are used for inference with means when the population standard deviation, s, is not known. Students should understand how and why conditions for inference with proportions and means are similar and different.

In continuation, the last topic students will discuss (if there is extra time in the school year) is an introduction to chi-square tests, which can be used when there are two or more categories. Students need to understand how to select from the following tests: the chi-square test for goodness of fit (for a distribution of proportions of one categorical variable in a population), the chi-square test for independence (for associations between categorical variables within a single population), or the chi-square test for homogeneity (for comparing distributions of a categorical variable across populations or treatments). The chi-square statistic is introduced to measure the distance between observed and expected counts relative to expected counts.

Essential Questions:

- How can you prepare for errors from significance test?
- How do you check conditions needed to carry out a test about a population proportion or mean?
- How do you compute expected counts, conditional distributions, and contributions to the chi-square statistics?
- How do you determine if there is a statistical significance?
- How do you interpret and find Type I and Type II errors?
- How do you state a correct hypotheses for a significance test about a population proportion or mean?
- How do you use a confidence interval to draw conclusions for a two-sided test about a population mean?
- How is probability used to express the strength of our conclusions?

- How is statistical inference used to draw conclusions from data?
- Is it reasonable to think that different people require different amounts of convincing?
- What does it mean to be 80, 90, 95 or 99% confident?
- What is a confidence interval?
- What is a two sample t-test and two sample z-test? How are they similar and different?
- What is a two sample t-test?
- What is the Goodness of Fit test for chi-square statistics?
- What is the homogeneity chi-square statistics?
- What makes an argument statistically convincing?
- When do you recognize paired data and apply a one-sample t-test to perform significance tests for such data?

Enduring Understandings:

- An interval of values should be used to estimate parameters, in order to account for uncertainty.
- Given that variation may be random or not, conclusions are uncertain.
- Probabilities of Type I and Type II errors influence inference.
- Significance testing allows us to make decisions about hypotheses within a particular context.
- The chi-square distribution may be used to model variation.
- The normal distribution may be used to model variation.
- The t-distribution may be used to model variation.

Lesson Titles:

- Chi-Square Goodness of Fit Test
- Chi-Square Test for Association/Independence
- Chi-Square Test for Homogeneity
- Choosing your Inference Method
- Comparing Population Proportions
- Comparing the Chi-Square Test
- Confidence Intervals for Means
- Confidence Intervals for Population Proportions
- Difference Between Two Means
- Errors and Power
- Margin of Error and Matched Pairs
- Relationship between Confidence Intervals and Significance Tests
- Significance Test for Proportions
- Significance Tests for Means

Standards/Indicators/Student Learning Objectives (SLOs):

MA.S-ID	Interpreting Categorical and Quantitative Data
MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
MA.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.
MA.S-ID.B	Summarize, represent, and interpret data on two categorical and quantitative variables
MA.S-IC	Making Inferences and Justifying Conclusions
MA.S-IC.A	Understand and evaluate random processes underlying statistical experiments
MA.S-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
MA.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.
MA.S-IC.B.5	Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
MA.S-IC.B.6	Evaluate reports based on data.

Career Readiness, Life Literacies, & Key Skills:

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.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.

Inter-Disciplinary Connections:

SOC.6.1.12.EconGE.1.a	Explain how economic ideas and the practices of mercantilism and capitalism conflicted during this time period.
SOC.6.1.12.EconNE.9.a	Explain how economic indicators are used to evaluate the health of the economy (i.e., gross domestic product, the consumer price index, the national debt, and the trade deficit).
SCI.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
SCI.HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Equity Considerations

Amistad Mandate

Topic:

Not Applicable

Materials Used:

Addresses the Following Component of the Mandate:

Holocaust Mandate

Topic:

We will discuss one of the following people:

John Kerrich and the Hypothesis testing behind his flipping the coin experiment.

- Click here to see the background of this problem (It is problem number 2 in this file)

Dr. Richard Korherr:

- He wrote a report for Nazi German about the population of the Jews in their occupied since 1933. He was the person in charge to use calculate such findings.

Materials Used:

- A copy of class notes

Addresses the Following Component of the Mandate:

- Holocaust Studies
- Prejudice

LGBTQ and Disabilities Mandate

Topic (Person and Contribution Addresses):

Alan Hart:

- Hart is a transgender person who lived from 189 to 1962. He was one of the key person to realized the x-ray (that were fairly new at that time) we important for detecting tuberculosis early and reduce its spread.

John Nash

- He is a mathematician who has schizophrenia.
- He worked on encrypted enemy telecommunications during WW2.

Materials Used:

- A copy of notes
- We will watch the movie "A Beautiful Mind" at the very end of the school year.

Addresses the Following Component of the Mandate:

- Social

Climate Change

There is a choice to use one or both of the problems listed below:

- Inference for Matched Pairs
    - Click here to see the material/problem on Skew the Scrip
- An example problem about Environmental Protection Agency and them wanting to know the proportion of fish that are inedible because of chemical pollution downstream of an offending factory.

Asian American Pacific Islander Mandate

Topic (Person and Contribution Addresses):

A problem about the National Research Council of the Philippines reported about members in biology and math who are women. For this problem the student has to estimate the difference in proportions for various confidence intervals.

Materials Used:

- A copy of notes.

Addresses the Following Component of the Mandate:

- Social

Instructional Strategies, Learning Activities, and Levels of Blooms/DOK:

For instructional strategies and learning activities please see formative and summative assessment.

Below is the levels of Blooms/DOK:

- Apply your knowledge about categorical and quantitative date to statistical inferences.
- Assess when to use homogeneity chi-square and goodness of fit test for chi-square statistics.
- Categorize whether the situation is a Type I or Type II error.
- Classify whether to use a population mean, population proportion, t-test or z-test for the given task at hand.
- Compare and contrast the differences between various confidence intervals and their z-score.
- Conduct a project that specifies in one of the inferences, identify which inference it is, solve the problem using the correct structure, and report the findings.
- Connect how do we use confidence intervals to draw conclusions for a two-sided test.
- Construct an argument about the consequences of a Type I and Type II error based on the real-world example.
- Define what is a statistical inference.

Modifications

ELL Modifications:

- Continue practicing vocabulary
- Focus on domain specific vocabulary and keywords
- Provide study guides prior to tests
- Read directions to the student
- Read test passages aloud (for comprehension assessment)
- Tutoring during Delsea One
- Vary test formats

IEP & 504 Modifications:

*All teachers of students with special needs must review each student's IEP. Teachers must then select the appropriate modifications and/or accommodations necessary to enable the student to appropriately progress in the general curriculum.

Possible Modifications/Accommodations: (See listed items below):

- Allow for redos/retakes

- Assign fewer problems at one time (e.g., assign only odds or evens)
- Differentiated center-based small group instruction
- Extra time on assessments
- Highlight key directions
- If a manipulative is used during instruction, allow its use on a test
- Opportunities for cooperative partner work
- Provide a word bank
- Provide reteach pages if necessary
- Provide several ways to solve a problem if possible
- Provide visual aids and anchor charts
- Test in alternative site
- Tiered lessons and assignments
- Tutoring during Delsea One
- Use of a graphic organizer
- Use of concrete materials and objects (manipulatives)
- Use of word processor

G&T Modifications:

- Alternate assignments/enrichment assignments
- Encourage Peer Leadership or mentoring
- Extension activities
- Higher-level cooperative learning activities
- Pairing direct instruction with coaching to promote self-directed learning
- Provide additional rigorous challenge problems for advance students
- Provide higher-order questioning and discussion opportunities
- Provide texts at a higher reading level
- Tiered assignments
- Tiered centers

At Risk Modifications

The possible list of modifications/accommodations identified for Special Education students can be utilized for At-Risk students. Teachers should utilize ongoing methods to provide instruction, assess student needs, and utilize modifications specific to the needs of individual students. In addition, the following may be considered:

- Additional help during tutoring/Delsea One
- Additional time for assignments
- Adjusted assignment timelines

- Agenda book and checklists
- Answers to be dictated
- Assistance in maintaining uncluttered space
- Books on tape
- Concrete examples
- Extra visual and verbal cues and prompts
- Follow a routine/schedule
- Graphic organizers
- Have students restate information
- No penalty for spelling errors or sloppy handwriting
- Peer or scribe note-taking
- Personalized examples
- Preferential seating
- Provision of notes or outlines
- Reduction of distractions
- Review of directions
- Review sessions
- Space for movement or breaks
- Support auditory presentations with visuals
- Teach time management skills
- Use of a study carrel
- Use of mnemonics
- Varied reinforcement procedures
- Work in progress check

Formative Assessment:

- Answer Avalanche
- Anticipatory Set
- Closure/Exit-Tickets
- Partner Answer/Analyze Questions
- Polling Questions
- Statistical Activities
- Think-Pair-Share
- Warm-Up

Summative Assessment:

- Benchmark

- Individual Assignment
- Marking Period Assessment
- Performance Task
- Projects
- Quizzes

Resources & Materials:

- AP Sample Questions
- Data investigations
- Each student will participate from either their seats or at one of the boards
- Formula Sheet
- Google Slide lessons
- Independent/Co-operative Learning explorations
- Teacher Generated Worksheets
- TI-84 Calculators
- White board and markers

Technology Materials and Standards

Computer Science and Design Thinking Standards

TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.A.5	Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.1.12.C.CS2	Communicate information and ideas to multiple audiences using a variety of media and formats.
TECH.8.1.12.C.CS3	Develop cultural understanding and global awareness by engaging with learners of other cultures.
TECH.8.1.12.D.CS2	Demonstrate personal responsibility for lifelong learning.
TECH.8.1.12.F.CS1	Identify and define authentic problems and significant questions for investigation.
TECH.8.1.12.F.CS2	Plan and manage activities to develop a solution or complete a project.
TECH.8.1.12.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.