Unit 3: Sampling Distributions

Content Area: **Mathematics**
Course(s): **Traditional Statistics**
Time Period: **January**
Length: **~6-7 weeks**
Status: **Published**

Unit Overview:

This unit applies probabilistic reasoning to sampling, introducing students to sampling distributions of statistics they will use when performing inference in Units 6 and 7. Students should understand that sample statistics can be used to estimate corresponding population parameters and that measures of center (mean) and variability (standard deviation) for these sampling distributions can be determined directly from the population parameters when certain sampling criteria are met. For large enough samples from any population, these sampling distributions can be approximated by a normal distribution. Simulating sampling distributions helps students to understand how the values of statistics vary in repeated random sampling from populations with known parameters.

Essential Questions:

- How can one prepare for errors from significance test?

- How can we determine whether a statistic is an unbiased estimator of a population parameter?

- How do we calculate the mean and standard deviation of the sampling distribution of a sample proportion p-hat for an SRS of size n from a population having proportion p of successes?

- How do we check to make sure our sample size is large enough?

- How do we distinguish between a parameter and a statistic?

- How do we find the mean and standard deviation of the sampling distribution of a sample mean x-bar from an SRS of size n?

- How do we use normal approximation to calculate probabilities involving p-hat?

- How do we use the sampling distribution of p-hat to evaluate a claim about a population proportion?

- How do you determine if there is a statistical significance?

- How is probability used to express the strength of our conclusions?

- How is statistical inference used to draw conclusions from data?

- What are the conditional checks for a normal distribution?

- What are the differences between a population distribution, sampling distribution, and the distribution of sample data?

- What is a parameter?

- What is a sampling distributions?

- What is a statistic?

- What is the relationship between a sample size and the variability of an estimator?

Enduring Understandings:

- Given that variation may be random or not, conclusions are uncertain.

- Probabilistic reasoning allows use to anticipate patterns in data

- Probability reasoning allows us to anticipate patterns in data

- The normal distribution may be used to model variation.

Standards/Indicators/Student Learning Objectives (SLOs):

MA.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.
MA.S-ID.A.3	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
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-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.A.2	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
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.
MA.S-MD.A	Calculate expected values and use them to solve problems
MA.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.
MA.S-MD.A.2	Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
MA.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.

Lesson Titles:

- Sampling Distribution of a Difference in Sample

- Sampling Distribution of a Sample Mean

- Sampling Distribution of a Sample Proportion

- Sampling Distributions of a Difference in Sample Means

- The Normal Distributions and Combining Normal Random

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:

There is a choice to pick one or both of the problem/people listed below:

- German Tank problem
    - This is a very common statistic problem to be used for this unit.
        - [Here is a link from Skew the Script to get an idea of how it works.](#)
- Talk about Albert Einstein and the work he has done.

Materials Used:

- A copy of class notes.
- Hand out from Skew the Script (or a handout similar to it).

Addresses the Following Component of the Mandate:

- Bias
- Holocaust Studies

LGBTQ and Disabilities Mandate

Topic (Person and Contribution Addresses):

Shakuntala Devi:

- She is known as the Human Calculator
- She is an advocate for the LGBTQ community

Materials Used:

- A copy of class notes

Addresses the Following Component of the Mandate:

- Social

Climate Change

Not applicable

Asian American Pacific Islander Mandate

Topic (Person and Contribution Addresses):

Diana Ma

- She is the Laker's statistician.

Materials Used:

- A copy of class notes
- A video of her talking about what she does
  - [Click here to watch](#)

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:

- Compare and contrast parameter distributions, statistics distribution and the distribution of sampling data.

- Define what is a parameter.

- Define what is a sampling distribution.

- Define what is a statistic.

- Estimate the mean and standard deviation of the sampling distribution.

- Generalize the pattern of how one solves a sample mean or sample proportion problems.

- Identify how we check to ensure our sample size is large enough.

- Infer whether a statistic is an unbiased estimator of a population parameter.

- Investigate how we adjust our pattern to when the problem is dealing with the difference between mean or proportion.

- Recite what is a Normal distribution.

- State what is the Central Limit Theorem (CLT) and what conditions do we need to check to test when we need to use it.

- State what is the conditional check for a normal distribution.

- Use context cues to determine if we are solving for a sample mean or sample proportion.

- Using our knowledge of sampling distributions, formulate which method to use, develop logical arguments and justify your conclusion for the real-world task at hand.

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.