05- Sampling Distributions

Content Area: **Mathematics**
Course(s): **AP Statistics**
Time Period: **January**
Length: **5-6 blocks**
Status: **Published**

Transfer

Exam Weighting: 7-12%

Previous Coursework: NA

Developing Understanding
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.

Building Course Skills
The probabilities associated with the normal distribution are what statisticians use to justify claims about populations they'll never be able to measure directly. Revisiting these properties early in Unit 5 will reinforce why sampling distributions allow statisticians to approximate parameters for the population of interest. Sketching, shading, and labeling a normal distribution aids in understanding the probability being calculated. Students should practice creating graphical representations, labeling the mean, and marking off values 1, 2, and 3 standard deviations from the mean. Students often struggle to interpret parameters of probability distributions in context, simply describing features of the graph rather than explicitly connecting those features to the situation described in the problem. Teachers can remind students that context is about a variable ("tip amounts," for example), not just the units (dollars). It's also critical that students explicitly show that the appropriate conditions have been verified, and that they avoid using nonspecific language like "it" in their interpretations. Using an error analysis strategy with sample responses can help familiarize students with these issues before they make similar mistakes.

Preparing for the AP Exam
Responses on the AP Exam often uncover gaps in understanding of sampling distributions. Students must clearly communicate whether they are talking about the distribution of a population, a sample of values (heights, for example), or a sample statistic from repeated samples (mean heights, for example). Broad generalizations, such as "larger samples have less variability," leave the exam reader unsure of whether the student is referring to variability within a sample (for which the statement would be false) or a sampling distribution. The word "it" often introduces ambiguity to a response. Students frequently show confusion about what condition to check when asserting that the sampling distribution of a given statistic is

approximately normal. Students should support normal probability calculations with a sketch or a calculation of a standardized score (z-score), rather than relying on calculator syntax.

Enduring Understandings

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

The normal distribution may be used to model variation.

Probabilistic reasoning allows us to anticipate patterns in data.

Essential Questions

How likely is it to get a value this large just by chance?

How can we anticipate patterns in the values of a statistic from one sample to another?

Student Learning Objectives

TEXT Section 7.1: What is a sampling distribution?

- Distinguish between a parameter and a statistic.
- Create a sampling distribution using all possiblesamples from a small population.
- Use the sampling distribution of a statistic to evaluate a claim about a parameter.
- Distiguish among the distribution of a population, the distribution of the a sample, and the sampling distribution of a statistic.
- Determine if a statistic is an unbiased estimator of a population parameter.
- Describe the relationship between sample size and the variability of a statistic.

TEXT Section 7.2:Sample Proportions

- Calculate the mean and standard deviation of the sampling distribution of a sample proportion and interpret the standard deviation.
- Determine if the sampling distribution of a sample proportion is approximately Normal.
- Calculate the mean and standard deviation of the sampling distribution of a difference in sample proportions and interpret the standard deviation.
- Determine if the sampling distribution of a difference in sample proportions is approximately Normal.
- If appropriate, use a Normal Distribution to calculate probabilities involving a sample proportion or a

difference in sample proportions.

TEXT Section 7.3: Sample Means

- Calculate the mean and standard deviation of the sampling distribution of a sample mean and interpret the standard deviation.
- Explain how the shape of the sampling distribution of a smaple mean is affected by the shape of the population distribution and the sample size.
- Calculate the mean and standard deviation of the sampling distribution of a difference in sample means and interpret the standard deviation.
- Determine if the sampling distribution of a difference in sample means is approximately Normal.
- If appropriate, use a Normal Distribution to calculate probabilities involving a sample mean or a difference in sample means.

Vocabulary and Planned Learning Experiences

Vocabulary: statistic, population distribution, sampling distribution, distribution of sample data, unbiased estimator, biased estimator, variability, sampling distribution of sample proportion, sampling distribution of a difference in sample proportions, sampling distribution of sample mean, sampling distribution of a difference in sample means, central limit theorem

Planned Learning Experiences:

Think Aloud: Group students into pairs within a larger group of four. Have each student individually read 2014 FRQ 3 and think aloud with their partner, brainstorming ways to begin each part of the question. Each student then independently completes all parts. Have the pairs compare answers within their groups, improving their individual responses as necessary. Groups can then compare their responses with other groups. Finally, have students score their responses according to the rubric.

Use Manipulatives: From a large container of pennies, have each student take two random samples of size 5, two of size 10, and two of size 25, and record the dates on those pennies. Have students calculate the mean of the dates in each sample and then construct four "dotplots" on the floor: one using the pennies, one using nickels placed at the mean of the student's sample size 5, one using dimes placed at the mean of the sample size 10, and one using quarters placed at the mean of the sample size 25.

Password-Style Games: Have partners sit facing opposite sides of the room. Display vocabulary terms from the unit on the classroom screen. Have the students facing the screen describe the terms to their partner who then tries to guess the terms described. After half of the terms have been used, have students switch roles. Terms to include: parameter, statistic, sampling distribution, distribution of sample data, sample distribution, unbiased estimator, sampling variability of a statistic, bias, sample proportion, sample mean, mean and standard deviation notaiton for sampling distributions, and central limit theorem.

Resources

TEXT: The Practice of Statistics, 6th Edition

AP Classroom and the APCD 2019 Course Description

Rossman-Chance Applets

Stats Medic

Assessments

Reading Quiz: What is a Sampliing Distribution? (Introductory Level)

Reading Quiz: Sample Proportions (Introductory Level)

Reading Quiz: Sample Means (Introductory Level)

Test: Sampling Distributions (AP Level)

Standards

Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

MA.S-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Modifications (ELL, Special Education, At-Risk Students, Gifted & Talented, & 504 Plans)

ELL:

- Use visuals
- Introduce key vocabulary before lesson
- Provide peer tutoring
- Guided notes and/or scaffold outline for written assignments

Supports for Students With IEPs:

- Allow extra time to complete assignments or tests
- Guided notes and/or scaffold outline for written assignments
- Work in a small group
- Follow all IEP modifications

At-Risk Students:

- Guided notes and/or scaffold outline for written assignments
- Introduce key vocabulary before lesson
- Work in a small group
- Lesson taught again using a differentiated approach
- Use visuals / Anchor Charts

Gifted and Talented:

- Create an enhanced set of introductory activities (e.g. advance organizers, concept maps, concept puzzles)
- Organize and offer flexible small group learning activities
- Teach cognitive and methodological skills
- Organize integrated problem-solving simulations
- Propose interest-based extension activities

Supports for Students With 504 Plans:

- Follow all the 504 plan modifications
- Text to speech/audio recorded selections