Statistics and Probability – UNIT 2
Designing and Evaluating Studies

Introduction: Instructional time should focus on designing and evaluating statistical studies. Students will learn the differences between sample surveys, observational studies, and experiments. Students will learn the consequences of bias and how to construct a study to minimize bias. In Unit 5, students will make inferences and conclusions based on the types of studies that they have learned in this unit.

CLUSTER	COMMON CORE STATE STANDARDS
Understand and evaluate statistical studies: sample surveys, experiments, and observational studies. Justify conclusions from statistical studies.	HSS.IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. HSS.IC.B.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. HSS.IC.B.6 Evaluate reports based on data.
MATHEMATICAL PRACTICES	**LEARNING PROGRESSIONS**
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.	Statistics and Probability Progression http://commoncoretools.me/wp-content/uploads/2012/06/ccss_progression_sp_hs_2012_04_21_bis.pdf

7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS	KEY VOCABULARY
• Students distinguish a population/parameter from a sample/statistic. • Students recognize the purpose for different random sampling methods (simple random sample, stratified, cluster, etc.). • Students compare and contrast sample surveys, observational studies, and experiments. • Students understand different experimental designs such as blocking and matched pairs.	• What is the difference between a statistic and a parameter? • What is the best sampling method given scenario? Justify your response. • Which types of studies allow you to conclude a causal relationship between two variables and why? • What are the key components of good experimental design?	Bias Blocking Census Cluster sampling Confounding Convenience sampling Double-blind experiment Individuals Nonresponse Placebo effect Population data Randomized experiment Sample size *(n)* Simple random sample Simulation Stratified sampling Systematic sampling Variable Voluntary Response

RESOURCES	INSTRUCTIONAL STRATEGIES	ASSESSMENT
• Graphing calculator: *randint(* command for random sampling • Random.org: Create random digits • The Data and Story Library (DASL): http://lib.stat.cmu.edu/DASL • *Against All Odds: https://www.learner.org/resources/series65.html* • AP Stats Monkey: This site includes a wonderful collection of resources written by teachers and collected by Jason Molesky. http://apstatsmonkey.com/StatsMonkey/Statsmonkey.html	• Emphasize that students should not just refer to a sampling method as biased. Students must be able to explain why a sampling method is biased and whether it will lead to an *overestimation* or *underestimation* of the parameter of interest. • Show students multiple methods for creating a simple random sample (SRS): putting slips of paper in a hat and mixing it, using dice/coins, using a table, and using technology (calculator or Random.org). • Emphasize the importance of random sampling. Have students create a graphic organizer	**Formative Assessment** SBAC – http://www.smarterbalanced.org/ **LAUSD Periodic Assessment** District assessments can be accessed through: http://achieve.lausd.net/math http://achieve.lausd.net/ccss Use your Single Sign On to access the Interim Assessments

RESOURCES	INSTRUCTIONAL STRATEGIES	ASSESSMENT
	comparing an SRS, stratified random sample, and cluster sample. They should compare the advantages and disadvantages of each. • You may choose to have the students design an experiment prior to learning about the key principles of experimental design. For example, ask them to design an experiment to determine if yoga reduces stress using 100 volunteers. You will be surprised to see how many students will incorporate the ideas of comparative groups, randomization, control, and replication prior to formally learning these concepts. • Have students write a proposal in which they will apply the full statistical investigative process. This could be part of a year-long project.	California will be administering the SMARTER Balance Assessment as the end of course for grades 3-8 and 11. The 11th grade assessment will include items from all High School Common Core strands, including Statistics and Probability. For examples, visit the SMARTER Balance Assessment at: http://www.smarterbalanced.org/

LANGUAGE GOALS for **low achieving, high achieving, students with disabilities and English Language Learners**

- Students will critique studies that have been published.

  Example: Since this survey was posted online, it was subject to voluntary response bias. This could lead to an over/under-estimation of…

- Students will explain orally or in writing how to incorporate randomization into a study.

  Example: Obtain a list of the names of the 100 subjects and assign each subject a number from 1-100. Use a random number generator to select 50 different numbers. The subjects who correspond to those 50 numbers will be assigned to the treatment group, and the remaining 50 subjects will be assigned to the control group.

- Students will design experiments and clearly explain orally or in writing how all principles of experimental design are incorporated.

  Example: In order to determine if listening to music while studying helps improve achievement, first we will randomly assign… We will maintain control by…

PERFORMANCE TASK

Does ginkgo improve memory? The law allows marketers of herbs and other natural substances to make health claims that are not supported by evidence. Brands of ginkgo extract claim to improve memory and concentration. A randomized comparative experiment found no statistically significant evidence for such effects. The subjects were 230 healthy volunteers over 60 years old. They were randomly assigned to ginkgo or a placebo pill (a dummy pill that looks and tastes the same). All the subjects took a battery of tests for learning and memory before treatment started and again after six weeks. (Moore, Basic Practice of Statistics, 5e, 2009)

(a) The study was double-blind. What does this mean?

(b) Comment briefly on the extent to which results of this study can be generalized to some larger population, and the extent to which cause and effect has been established.

(c) Explain why it is more advantageous to use 230 volunteers in this study, rather than 30.

(d) Using the random digits below (starting at line 103), choose the first four members of the ginkgo group. Explain your method.

103	45467	71709	77558	00095	32863	29485	82226	90056
104	52711	38889	93074	60227	40011	85848	48767	52573
105	95592	94007	69971	91481	60779	53791	17297	59335
106	68417	35013	15529	72765	85089	57067	50211	47487

DIFFERENTIATION 🕮		
UDL/ FRONT LOADING	ACCELERATION	INTERVENTION
Statistics and Probability: • As an opening activity, guide students in the design and execution of an in class experiment (e.g. taste test of different types of bottled water - determine a question of interest, what variables to collect, who are the observational units, how is it random). Students use "common sense" to design an experiment, then the teacher can connect experiment vocabulary throughout the unit back to students' original ideas). • Statistical problem solving is an investigative process that involves four components: formulate questions, collect	Acceleration for high achieving students: Encourage students to find studies that have incorporated different forms of random sampling, including a multi-stage design. Ask them to explain why they think that the people who planned the study chose each method. Help students distinguish stratified sampling from cluster sampling: in a stratified sample, the population is divided into strata and sample "some from all;" whereas in a cluster sample, we divide the population into clusters and sample "all from some."	• Make a foldable for students to write down all of the important vocabulary in the unit, along with their definitions/applications. Another strategy to build understanding of vocabulary would be to use a word wall in the classroom or have the students create a word puzzle. • Provide graphic organizers for survey and experimental design.

DIFFERENTIATION 🕮		
UDL/ FRONT LOADING	ACCELERATION	INTERVENTION
data, analyze data, and interpret results. The connection should be reviewed prior to detailing all of the principles of a good experimental design. • Make the connection between hypotheses and conclusions in science classes and the current unit.	As a group project, have students design and conduct an experiment to investigate the effects of response bias in surveys. Allow them to choose the specific topic, but ensure that their topic can answer at least one of the following questions (adopted from Josh Tabor): • Can the wording of a question create response bias? • Does providing additional information create response bias? • Do the characteristics of the interviewer create response bias? • Does anonymity change the responses to sensitive questions? • Does manipulating the answer choices/order of answer choices change the response? • Can revealing other peoples' answers to a question create response bias?	