# Statistics - Unit B - Research Design

## Unit Focus

This unit explores the process of collecting and interpreting data. Students investigate sampling as a method of understanding information about populations. It includes discussion of uncertainty in samples and how the margin of error narrows as sample size grows. Students review articles with sampling and review the validity of the statistical processes used to obtain data. Experimentation is introduced. Students learn about the basic principles of experiment design, including: explanatory versus response variables, the definition of statistical significance, adjusting for confounding variables, and double blind experiments. Students explore the ethical complexities of experimentation in a review of the movie Miss Evers' Boys, which is a historical account of the controversial Tuskegee Syphilis Study.

## Stage 1: Desired Results - Key Understandings

### Standard(s)

**Common Core**
Mathematics: 9-12

- Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (CCSS.MATH.CONTENT.HSS.IC.A.1)
- Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. (CCSS.MATH.CONTENT.HSS.IC.B.3)
- 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. (CCSS.MATH.CONTENT.HSS.IC.B.4)
- Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. (CCSS.MATH.CONTENT.HSS.IC.B.5)
- Evaluate reports based on data. (CCSS.MATH.CONTENT.HSS.IC.B.6)

- Reason abstractly and quantitatively. (CCSS.MATH.MP.2)
- Construct viable arguments and critique the reasoning of others. (CCSS.MATH.MP.3)
- Use appropriate tools strategically. (CCSS.MATH.MP.5)
- Attend to precision. (CCSS.MATH.MP.6) Look for and make use of structure. (CCSS.MATH.MP.7)

**Madison Public Schools Profile of a Graduate**

### Transfer

*Students will be able to independently use their learning to...*
**T1** draw conclusions about graphs, shapes, equations, or objects.
**T2** evaluate the accuracy and efficiency of a given solution.
**T3** justify reasoning using clear and appropriate mathematical language.

### Meaning

#### Understanding(s)

*Students will understand that...*
**U1** Mathematicians compare the effectiveness of various arguments, by analyzing and critiquing solution pathways
**U2** Mathematicians continually evaluate their process and the reasonableness of the intermediate results.
**U3** Mathematicians select and use appropriate statistical methods and tools to analyze data, show trends, and describe or make predictions.
**U4** Mathematicians analyzed data to evaluate inferences, make predictions and/or communicate a decision.

#### Essential Question(s)

*Students will keep considering...*
**Q1** How do we appropriately challenge the validity of sampling methods?
**Q2** How do we communicate the precision and confidence of sampling results?
**Q3** What makes experimentation statistically valid?
**Q4** How do ethics influence statistical practices?

### Acquisition of Knowledge and Skill

#### Knowledge

*Students will know...*
**K1** convenience sampling and voluntary response sampling are often biased
**K2** the characteristics of a simple random sample
**K3** the two types of error in estimation

#### Skill(s)

*Students will be skilled at...*
**S1** Identifying the population and parameter of interest

## Stage 1: Desired Results - Key Understandings

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| • Analyzing: Examining information/data/ evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2) | **K4** how to manage bias and variability when sampling<br>**K5** the meaning of the phrase '95% confidence"<br>**K6** that the conclusion of a confidence statement applies to the population, not to the sample<br>**K7** that our conclusion about the population is never completely certain<br>**K8** a sample survey can choose to use a confidence level other than 95%<br>**K9** that to produce a smaller margin of error with the same confidence take a larger sample<br>**K10** examples of sampling and of nonsampling errors<br>**K11** how to choose a stratified random sample<br>**K12** all good samples are probability samples (a sample chosen by chance)<br>**K13** the first goal of an experiment is to ensure that it will show us the effect of the explanatory variables on the response variables<br>**K14** the basic principles of experimental design<br>**K15** a good comparative study measures and adjusts for confounding variables<br>**K16** the advantages and disadvantages of a double-blind experiment<br>**K17** how to determine if findings from an experient are statistically significant<br>**K18** the role of the institutional review board, informed consent, and confidentiality is not the same as anonymity<br>**K19** Vocabulary: sample, populations, voluntary response, biased, convenience sampling, random digits, parameter, statistic, bias, variability, margin of error, sampling errors , random sampling error, nonsampling errors, processing errors, undercoverage, processing errors, response errors, nonresponse, strata, experiments, subjects, treatments, confounding, lurking variable, clinical trials, placebo effect, control group, randomize, statistically significant, comparative, matching, causes, nonadherers, dropouts, generalize, completely randomized designs, matched pairs design, block design, institutional review board, informed consent, confidential | **S2** Recognizing bias due to voluntary response samples and other inferior sampling methods.<br>**S3** Choosing a simple random sample<br>**S4** Using a table of random digits to select a simple random sample (SRS) from a population<br>**S5** finding the margin of error for 95% confidence roughly using $1/\sqrt{n}$ (n=sample size)<br>**S6** asking good questions about a poll before paying attention to the poll results<br>**S7** Understanding the distinctions between sampling errors and nonsampling errors<br>**S8** Use random digits to select a stratified random sample from a population when the strata are identified. (level 2 only) |