

### Year Long Mathematical Practices (MP):

Display perseverance and patience in problem-solving. Demonstrate skills and strategies needed to succeed in mathematics, including critical thinking, reasoning, and effective collaboration, and expression. Seek help and apply feedback. Set and monitor goals.

**MP.1** – Make sense of problems and persevere in solving them.

**MP.2** – Reason abstractly and quantitatively

**MP.3** – Construct viable arguments and critique reasoning of others.

**MP.4** – Model with mathematics.

**MP.5** – Use appropriate tools strategically.

**MP.6** – Attend to precision.

**MP.7** – Look for and make use of structure.

**MP.8** – Look for and express regularity in repeated reasoning.

### Semester 1 (August-December)

#### **Unit 1: Statistical Modeling (3-4 weeks)**

In Unit 1 students will utilize the Framework for Statistical Reasoning as the conceptual blueprint for making sense of and considering every scenario throughout the Statistical Reasoning course. Data consists of structure and variability. Mathematical modeling looks for and describes structure. Statistical modeling extends mathematical modeling by describing the variability in the data around the structure. Statistical representations are evaluated by how well they describe the data and whether the representations are useful.

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#### **Overarching Standards for Unit 1**

**MM.1:** Apply mathematics to real-life situations; model real-life phenomena using mathematics.

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#### **Standards for Student Mastery for Unit 1**

**MM.1.1:** Explain applicable, mathematical problems using a mathematical model.

**MM.1.2:** Create mathematical models to explain phenomena that exist in the natural sciences, social sciences, liberal arts, fine and performing arts, and/or humanities domains.

**MM.1.3:** Use abstract and quantitative reasoning, make decisions about information and data from a real-life situation.

**MM.1.4:** Use various mathematical representations and structures with this information to represent and solve real-life problems.

### Unit 2: Statistics as a Problem-Solving Process and the Role of Questioning (3-4 weeks)

In Unit 2 students will understand reasons for the importance of using the Framework for Statistical Reasoning. It is core to reasoning statistically with data to draw appropriate conclusions. Students should clearly understand the role of the four components: Ask, Collect, Analyze, and Interpret. Continual critiquing of the process and conclusions drawn at each phase should take place cyclically, possibly necessitating revisiting a previous phase to make revisions. Understanding the role of questioning at each phase of the Framework is essential. Throughout the Framework, students will ask interrogative questions for the opportunity to reflect on their work before proceeding to the next phase. These interrogative questions provide precision and clarity to the wording of the investigative question that will be posed to make sense of the context under consideration. This includes distinguishing between descriptive, comparative, and associative statistical investigative questions. Students are encouraged to formulate multivariate investigative questions. Survey/data collection questions will also be posed to collect data for answering the investigative question. Interrogative questions for this phase provide the opportunity to determine if the data collected is appropriate for answering the investigative question. Students will use tools to strategically collect their data as well as attend to the precision of the data. They will also ask analysis questions of the data collected or considered. Interrogating the analysis questions is important to determine if the analysis is useful in answering the investigative question. Students will utilize patterns and structure to make sense of their analysis. In the interpret phase, interrogative questions will provide insight for how well the statistical investigative question has been answered as well as any follow-up investigative questions that emerge.

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#### Overarching Standards for Unit 2

- DSR.2:** Formulate statistical investigative questions of interest to students that can be answered with data.
- MM.1:** Apply mathematics to real-life situations; model real-life phenomena using mathematics.

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#### Standards for Student Mastery for Unit 2

- DSR.2.1:** Formulate statistical investigative questions about a population using samples taken from the population.
- DSR.2.2:** Formulate comparative and associative statistical investigative questions for surveys, observational studies, and experiments to compare two or more groups or to investigate the association of two or more variables.
- DSR.2.3:** Formulate multivariable statistical investigative questions.
- DSR.2.4:** Formulate inferential statistical investigative questions regarding association and prediction.

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- MM1.1:** Explain applicable, mathematical problems using a mathematical model.

# Statistical Reasoning

## Mathematics



- MM.1.2:** Create mathematical models to explain phenomena that exist in the natural sciences, social sciences, liberal arts, fine and performing arts, and/or the humanities.
- MM.1.3:** Use abstract and quantitative reasoning, make decisions about information and data from a real-life situation.
- MM.1.4:** Use various mathematical representations and structures with this information to represent and solve real-life problems.

### Unit 3: Collecting/Considering Data and Types of Studies (6-7 weeks)

In Unit 3 students will distinguish between primary and secondary data in the data collection process to answer the statistical investigative question. The different methods for collecting and considering data will be explored and evaluated using reasonable tools and strategies. This includes critiquing the differences and similarities among surveys, experiments, and observational studies. Students will grapple with and evaluate the role of randomization and its impact on conclusions that can be made from the data about a population. This includes distinguishing between the role of random selection from a population and random assignment in an experiment. Based upon the type of study conducted, potential sources and consequences of bias and confounding variables should be described. Given the abundance of data that is generated daily, it is essential that students consider the ethical use of data and privacy issues that may be associated with data.

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#### Overarching Standards for Unit 3

- DSR.3:** Collect data by designing and implementing a plan to address the formulated statistical investigative question.
- MM.1:** Apply mathematics to real-life situations; model real-life phenomena using mathematics.

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#### Standards for Student Mastery for Unit 3

- DSR.3.1:** Apply an appropriate data-collection plan when collecting primary or secondary data for the statistical investigative question of interest.
  - DSR.3.2:** Distinguish between surveys, observational studies, and experiments.
  - DSR.3.3:** Design sample surveys, experiments, and observational studies using accepted practices.
  - DSR.3.4:** Distinguish between random selection and random assignment and identify their impact on conclusions.
  - DSR.3.5:** Describe potential sources and effects of bias and confounding variables.
  - DSR.3.6:** Describe and adhere to the ethical use of data (e.g., sensitive information, privacy, and living subjects).
  - DSR.3.7:** Identify when data can be generalized to a target population.
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- MM1.1:** Explain applicable, mathematical problems using a mathematical model.
  - MM.1.2:** Create mathematical models to explain phenomena that exist in the natural sciences, social sciences, liberal arts, fine and performing arts, and/or the humanities.
  - MM.1.3:** Use abstract and quantitative reasoning, make decisions about information and data from a real-life situation.
  - MM.1.4:** Use various mathematical representations and structures with this information to represent and solve real-life problems.

### Semester 2 (January-May)

#### **Unit 4: Analyzing Data and the Role of Distributions (7-8 weeks)**

In Unit 4 students will recognize that the first step in analyzing data collected on a variable is to explore the data by utilizing appropriate graphs and numerical summaries, depending upon the type of data. The desired outcome is to describe key features of the distribution of the variable where the distribution depicts how the observations fall across the range of possible values. For categorical data, bar graphs and tables are commonly used for sample (data) distributions. For quantitative data, histograms, dot plots, box plots, and scatter plots are commonly used for sample (data) distributions. Numerical summaries can include modal category, sample proportion, conditional proportions, and relative risk for categorical data. For quantitative data, numerical summaries can include mean, median, standard deviation, IQR, and correlation coefficient. It is important to ask interrogative questions during the analysis phase of the Framework for Statistical Reasoning to ensure the appropriate graphical representations and numerical summaries for the sample data are considered. After exploring the sample data collected, students will transition to inferential analysis by simulating a sampling distribution of the appropriate sample statistic to describe sample-to-sample variability. This will allow inference to a population through the use of simulated p-values and margins of error.

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#### **Overarching Standards for Unit 4**

- DSR.4:** Analyze data by selecting and using appropriate graphical and numerical methods.
- MM.1:** Apply mathematics to real-life situations; model real-life phenomena using mathematics.

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#### **Standards for Student Mastery for Unit 4**

- DSR.4.1:** Summarize quantitative or categorical data using tables, graphical displays, and numerical summary statistics.
  - DSR.4.2:** Summarize and describe relationships among multiple variables.
  - DSR.4.3:** Use sampling distributions developed through simulation to describe the sample-to-sample variability of sample statistics.
  - DSR.4.4:** Use sampling distributions to compute simulated p-values.
  - DSR.4.5:** Describe the relationship between two quantitative variables by interpreting correlation ( $r$ ) and a least-square regression line (using technology).
  - DSR.4.6:** Use simulations to investigate associations between two categorical variables and to compare groups.
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- MM1.1:** Explain applicable, mathematical problems using a mathematical model.

# Statistical Reasoning

## Mathematics



- MM.1.2:** Create mathematical models to explain phenomena that exist in the natural sciences, social sciences, liberal arts, fine and performing arts, and/or the humanities.
- MM.1.3:** Use abstract and quantitative reasoning, make decisions about information and data from a real-life situation.
- MM.1.4:** Use various mathematical representations and structures with this information to represent and solve real-life problems.

### Unit 5: Interpreting Results to Answer the Statistical Investigative Question (5-6 weeks)

In Unit 5 students will use the results of the analysis phase of the Framework for Statistical Reasoning to answer the posed statistical investigative question(s). Students will use statistical arguments and evidence to make inferences about the population or experimental treatments under consideration based upon the analysis of the sample data, the p-values, and margins of error from simulated sampling distributions. They will interpret p-values and margins of error appropriately to determine the plausibility of a population characteristic. Students will also ask questions at this phase to determine if the analysis answers the posed investigative question(s), to ask if other variables might affect the analysis, and to determine if further analysis should be conducted.

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#### Overarching Standards for Unit 5

- DSR.5:** Interpret the results of the analysis, making connections to the formulated statistical investigative question.
- MM.1:** Apply mathematics to real-life situations; model real-life phenomena using mathematics.

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#### Standards for Student Mastery for Unit 5

- DSR.5.1:** Use statistical evidence from analyses to answer the formulated statistical investigative questions.
  - DSR.5.2:** Interpret the impact of outliers, missing values, or erroneous values on the results.
  - DSR.5.3:** Use and interpret the p-value to determine whether the estimate for a population characteristic is plausible.
  - DSR.5.4:** Interpret a given margin of error associated with an estimate of a population characteristic.
  - DSR.5.5:** Explain the impact of multiple variables on one another.
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- MM1.1:** Explain applicable, mathematical problems using a mathematical model.
  - MM.1.2:** Create mathematical models to explain phenomena that exist in the natural sciences, social sciences, liberal arts, fine and performing arts, and/or the humanities.
  - MM.1.3:** Use abstract and quantitative reasoning, make decisions about information and data from a real-life situation.
  - MM.1.4:** Use various mathematical representations and structures with this information to represent and solve real-life problems.



### Unit 6: Culminating Capstone Unit (2-3 weeks)

Students will utilize the Framework for Statistical Reasoning to carry out their own investigations, using the cumulative tools from throughout the course and thinking beyond the concepts presented in Statistical Reasoning. Students should be asked, “What do you now wonder about in the world around you?” Students should be encouraged to explore data science topics such as photos, social media communications, and classification. The role of computational thinking in this non-traditional data should be considered as well as the role of technology.

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#### Overarching Standards for Unit 6

- DSR.2:** Formulate statistical investigative questions of interest to students that can be answered with data.
- DSR.3:** Collect data by designing and implementing a plan to address the formulated statistical investigative question.
- DSR.4:** Analyze data by selecting and using appropriate graphical and numerical methods.
- DSR.5:** Interpret the results of the analysis, making connections to the formulated statistical investigative question.
- MM.1** Apply mathematics to real-life situations; model real-life phenomena using mathematics.

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#### Standards for Student Mastery for Unit 6

ALL associated learning objectives.