



Curriculum & Instruction

SUMMIT PUBLIC SCHOOLS

Content Area: Mathematics
Course: Statistics & Discrete Math (H253)
Grade(s): 12

Course Overview

The goal of this course is to expose students to practical mathematics that they can expect to encounter in their world. Students who complete this course will be proficient in gathering, displaying, and interpreting statistics in context. In the second half of the course, students will be exposed to discrete mathematics topics that can be directly applied to a wide variety of fields, including computer science, business, manufacturing, life sciences, and mathematics.

This course explores many facets of data analysis. Topics include descriptive statistics for univariate and bivariate data, experimental design, probability, probability distributions, anticipating patterns and inferential statistics. Examples will be taken from various fields and student-created projects will be utilized throughout the course. Topics in Discrete Mathematics (the study of mathematical structures whose solutions are limited to distinct, separated values) include graph theory, network theory, voting theory, fair division and Euler circuits. Discrete Mathematics offers another opportunity to have students experience the application of mathematics in real world settings. Technology will be used extensively.

Prerequisite: Algebra 2

New Jersey State Learning Standards

Summit Public Schools curriculum aligns with the [New Jersey Student Learning Standards](#).

Content Area Standards:

- S-CPA.1+: Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").
- S-CPA.2+: Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
- S-CPA.3+: Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

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- S-CP.A.5+: Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
- S-CP.B.6+: Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.
- S-CP.B.7+: Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.
- S-CP.B.8: Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$, and interpret the answer in terms of the model.
- S-IC.A.1+. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- S-IC.A.2+. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
- S-IC.B.3+. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
- 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.
- S-IC.B.5+. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
- S-ID.A.1. Represent data with plots on the real number line, including dot plots, histograms, and box plots.
- S-ID.A.2. Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets.
- 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)
- S-ID.A.4. use the mean and standard deviation of a dataset 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.
- S-ID.B.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
- S-ID.B.6: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
- S-ID.C.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- S-ID.C.8: Compute (using technology) and interpret the correlation coefficient of a linear fit.
- S-ID.C.9: Distinguish between correlation and causation.
- 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.
- S-MD.A.2+: Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
- 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.
- S-MD.B.5+: Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

- S-MD.B.7+: Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, playing the Lottery).

Interdisciplinary Standards:

- RI.MF.9–10.6. Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.
- RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- 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.

Career Readiness, Life Literacies and Key Skills Standards:

- 9.4.8.CI.3: Examine challenges that may exist in the adoption of new ideas
- 9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option
- 9.4.8.DC.7: Collaborate within a digital community to create a digital artifact using strategies such as crowdsourcing or digital surveys.
- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
- 9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.
- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions
- 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience
- 9.4.12.IML.9: Analyze the decisions creators make to reveal explicit and implicit messages within information and media
- 9.4.12.IML.8: Evaluate media sources for point of view, bias, and motivations
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem

Computer Science and Design Thinking Standards:

- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

Career Readiness Practices

- CRP 1. Act as a responsible and contributing citizen and employee.
- CRP 2. Apply appropriate academic and technical skills.
- CRP 3. Attend to personal health and financial well-being.
- CRP 4. Communicate clearly and effectively and with reason.
- CRP 5. Consider the environmental, social and economic impacts of decisions.
- CRP 6. Demonstrate creativity and innovation.
- CRP 7. Employ valid and reliable research strategies.
- CRP 8. Utilize critical thinking to make sense of problems and persevere in solving them.
- CRP 9. Model integrity, ethical leadership and effective management.
- CRP 10. Plan education and career paths aligned to personal goals.
- CRP 11. Use technology to enhance productivity.
- CRP 12. Work productively in teams while using cultural global competence.

New Jersey Curriculum Mandates:

This curriculum integrates lessons that address the following interdisciplinary New Jersey Curriculum Mandates:

- Diversity and Inclusion (Grades K - 12)
 - C.18A:35-4.36a: Curriculum to include instruction on diversity and inclusion.
 - (3) encourage safe, welcoming, and inclusive environments for all students regardless of race or ethnicity, sexual and gender identities, mental and physical disabilities, and religious beliefs.

Learning Objectives

Learning objectives are clear, specific statements that define what students should know, understand, and be able to do by the end of a lesson or course.

Students will understand that...

- Although difficult to execute, random studies are critical for drawing representative samples of populations.
- Variation can be expected in the results of random samples, and is affected by the design of the sample or experiment.
- Although there are differences in design and purpose between sample surveys, experiments, and observational studies, they all use randomization to generate a conclusion about a population from a sample.
- Bias can affect the results of the sample by poorly selecting the sample, or by misleading the sample space.

- a single variable can be displayed using a graph or a numeric summary. Both of these methods provide ways to describe the shape, center, and spread of the data.
- data can be measured using words or numbers, which can be discrete or continuous. Scatter plots are particularly helpful for graphing and comparing two quantitative variables.
- data that has a linear relationship can be described using a linear model and a correlation (r) value.
- A probability model can be discrete or continuous. Simple probability rules can be used to find the probability of an event within a probability model.
- The independence of events and conditional probabilities have an important relationship.
- Expected value can be interpreted as the mean of a probability distribution, and is used to make a reasonable prediction about the outcome of an event. Expected values can allow students to successfully form strategies and make decisions.
- Sampling distributions are approximately normal when n is large, regardless of the distribution of the data.
- Confidence intervals can be set up from sample data to make inferences about an unknown parameter.
- Euler paths and circuits can be used to model deliveries, emergency routes and other municipal needs.
- There are many algorithms to find the most efficient Hamiltonian circuit, such as brute force, nearest neighbor and sorted edges.
- How to apply Dijkstra's algorithm to find the shortest path from one vertex to another.
- There are many algorithms used to find minimum-cost spanning trees such as Kruskal's Algorithm and Prim's Algorithm.
- The pros and cons of plurality voting, Borda count, instant runoff and pairwise comparison.
- How to apply and draw conclusions from the fairness criteria: majority, Condorcet, monotonicity and independence of irrelevant choices (IIA)
- How to apply the method of sealed bids, and the assumptions made and problems with such a method.
- How to apply the different cake-cutting methods or the method of markers for multiple items.
- How to encrypt and decrypt messages using Caesar, substitution, transposition and Vigenere ciphers.

Units of Study

Units of study are organized collections of lessons and learning experiences focused on a specific topic and set of skills within a course. Each unit is guided by a set of essential questions.

Unit 1: Sampling, Bias, Surveys, Experiments, & Simulations (~10 Days) - Chapter 3

- How can random processes in statistics be simulated and evaluated?
- How do sample surveys, experiments, and observational studies differ? How can inferences and conclusions be drawn from each?
- What factors can influence the outcome and validity of a study?

Unit 2: Interpreting Categorical and Quantitative Data

- Displaying Data Numerically and Graphically (~7 Days) - Chapter 1
- Normal Density Curves Part 1 (~9 Days) - Chapter 5

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- Correlation, Regression, & LSRL (~9 Days) - Chapter 2
 - How can data on a single variable be summarized, represented, and interpreted?
 - What are categorical vs. quantitative variables? How can two variables be summarized, represented, and interpreted?
 - How can linear models be interpreted in statistics?

Unit 3: Probability, Decisions, Sampling Distributions and Inference

- Probability (~12 Days) - Chapter 4
- Normal Distributions Part 2 (~21 Days) - Chapter 5
- Inference, Sample Means, and Confidence Intervals (~13 Days) - Chapters 6/7
 - How can the probability of compound events in a probability model be computed?
 - How can independence and conditional probability be used to interpret data?
 - What is expected value? How can probability be used to evaluate the outcomes of decisions?
 - What would the sampling distribution look like and what can be interpreted from it?
 - How can a confidence interval be constructed and interpreted?

Unit 8: Discrete Math

- Graph Theory (~15 Days)
- Voting (~8 Days)
- Fair Division (~8 Days)
- Cryptography (~6 Days)
 - How can a mailman take the most efficient path to reach every destination?
 - How can a traveling businessman find the most efficient way to visit multiple cities?
 - How can a GPS device find the shortest route from one city to another?
 - How can a computer network or electrical grid be set up so that costs are minimized?
 - What voting methods can be used when more than two choices are presented to us?
 - What are some indications that an election might not be “fair?”
 - How can someone divide an estate when there are fewer items than there are recipients?
 - How can someone divide a plot of land or many items of similar value?
 - How can messages be encrypted and decrypted, and historically how have ciphers become more complex?

Instructional Resources and Materials

Instructional resources are the information sources teachers utilize to guide their teaching and assessing. Instructional materials are the texts students read or review. The instructional resources and materials may vary in order to meet the learning needs of students.

- Guided Note Outlines
- [Google Classroom](#)
- [DeltaMath](#)
- [Desmos](#)
- [Khan Academy](#)
- [NJ Standardized Test Prep Resources](#)

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- [Kuta Software](#)

Assessment Strategies

Assessment measures a student's mastery of a course standard and learning objective. Assessment can be used for both instructional purposes and for evaluative purposes. Teachers may choose one or more of the following ideas to assess learners. They may also modify these ideas to make the assessment more responsive to students' interests and needs.

Formative: Practice Problem Sets, Homework Exercises, Exit Tickets, Graded Check-Ins

Summative: Quizzes & Unit Tests

Benchmark: Midterm and Final Exams

Alternative: Projects

Suggested Strategies for Modification & Differentiation

[Modifications Chart](#)