Washington Township School District

The mission of the Washington Township Public Schools *is to provide a safe, positive, and progressive educational environment that provides opportunity for all students to attain the knowledge and skills specified in the NJ Learning Standards at all grade levels, so as to ensure their full participation in an ever-changing world as responsible, self-directed and civic-minded citizens.*

Course Title:	**Data Science**
Grade Level(s):	High School 11th and 12th Grade

Duration:	*Full Year:*	**X**	*Semester:*		*Marking Period:*	
Course Description:	In this course, students will be introduced to the main ideas in data science through free tools such as Google Sheets, Microsoft Excel, RStudio, etc. Students will learn to be data explorers in project-based units, through which they will develop their understanding of data analysis, sampling, correlation/causation, bias and uncertainty, probability, modeling with data, making and evaluating data-based arguments, the power of data in society, etc. At the end of the course students will have a portfolio of their data science work to showcase their newly developed abilities.					
Grading Procedures:	Each semester will be a composite of quiz scores, test scores, homework, and participation reflecting a student's mastery of the areas outlined above. The student can pass the course with an overall average of 70%. The individual teacher will explain the grading system to the student.					
Primary Resources:	NJ Student Learning Standards (NJSLS) NJ Computer Science Standards YouCubed Online Data Science Course *Programming Skills for Data Science,* published by Pearson					

Washington Township Principles for Effective Teaching and Learning

- Implementing a standards-based curriculum
- Facilitating a learner-centered environment
- Using academic target language and providing comprehensible instruction
- Adapting and using age-appropriate authentic materials
- Providing performance-based assessment experiences
- Infusing 21st century skills for College and Career Readiness in a global society

Designed by:	Michael Wong

Under the Direction of:	Dr. Carole English

Written: Summer 2022

Revised: _____

BOE Approval: _____

Unit Title: Introduction to Data Science

Unit Description: In this unit students will be introduced to data science through a reflection of their own experiences using self-generated data, an exploration of a larger dataset of people's media use, and an analysis of business data. Through these activities students will learn about the data science process, begin using data to tell stories, and think about the ethics involved in working with data. Students will be using programs such as Google Sheets/Microsoft Excel, CODAP, RStudio, etc. to represent data, explore data, and understand the story the data is telling us.

Unit Duration: Approximately 5 Weeks

Desired Results

Standard(s):
HSS-ID.A.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

HSS-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

HSS-ID.B.6: Represent data on two quantitative variables on a scatter plot and describe how the variables are related.

Indicators:
Represent data with plots on the real number line (dot plots, histograms, and box plots).

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

Classify data as quantitative or qualitative, choose and create appropriate data displays, and analyze misleading graphs.

Understandings:
Students will understand that…

- Data Science is the study of data.
- Data Science involves recording, storing, and analyzing data to extract information.
- Visualizing data helps interpret the story the data is trying to tell.
- There are multiple ways to gather, record, and represent data.
- The Data Science Process is used to help effectively record data, model it, analyze it, and communicate results.
- Variability is an aspect of all of life that students can analyze and represent through data science and data visuals. There is variability in anything that changes.
- Models are how recorded data are visually represented. Some methods are better than others.
- All data tells a story.

Essential Questions:

- What exactly is Data Science?
- What are data, variability, and models?
- Describe how data is generated.
- How could you create a story from given data?
- What is Data Ethics? Can you create real life scenarios where Data Ethics comes in to play?
- Why do you think Data Ethics is important?

- Data Ethics is how people choose to use the data they gathered. What they choose to do with the data can have impacts on society that are both good and bad.

Assessment Evidence

Performance Tasks:

Students will be able to…

- Describe what Data Science is and give real life examples that they can relate to.
- Describe the different steps/phases of the Data Science Process.
- Explore variability within their own daily lives.
- Analyze data visualizations to identify sources of variability and make conclusions about what the graphs are saying.
- Dig deeper into the data science process and make a plan to collect their own data outside of class.
- Describe the basics of data ethics by exploring how the government and companies collect data.
- Analyze data visualizations to determine the story they tell and how they may be misleading.
- Reflect on their data gathering and strategize how to create a visual representation of the data they collected.
- Use CODAP to model, analyze, and synthesize the data.

Other Evidence:

- Class discussions
- Independent Work
- Group Work
- Weekly Reflections
- Projects
- Data Talks

Benchmarks:

Dear Data Project
Me & The Bees Business Report
Class Discussions/Data Talks

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. Basketball Activity
   Observe visual model of Stephen Curry's shooting on the court. The class will discuss what they notice about the model. Students should notice there are certain areas that have higher percentage than other areas. This will allow us to talk about Variability. As a class students can talk about where else they see variability in the world. The class will start talking about the Data Science Process and how Data Scientists use it.
3. Group Work Norms Activity

Group work will an important part of this course and students will use it to fuel many of the class discussions. It is important that students talk about what is expected when working in groups. As a class, brainstorm ideas for what ideal group work would be like. The class will discuss likes and dislikes. It is important that all class members participate and vocalize their thoughts.

4. Dear Data Project
   This activity will be an opportunity for students to explore variability within their lives visually. Students will start by watching the Big Bang Data YouTube video and discuss what Giorgia Lupi and Stefanie Posavec did. After, students will break into groups and begin looking at the different sets of Postcards. Groups will be working on exploring one of the four. Once groups have finished their exploration of the postcards, they will move to share ideas in jigsaw groups in which each pair of postcards is represented. From here, the class will be making their own version of the postcards over the next few days. Students will need to consider variability in their day-to-day experience around the topic of their choice and how to capture it. They will be shown examples created by the teacher to assist. From here, students will move onto the modeling phase of the data science process. Students will be encouraged to be creative. Students will start with a rough draft, and maybe even create a key. Students will share their drafts with a peer for feedback. After this, students will revise their drafts and present their final product to the class.
5. Pew Data investigation and Spreadsheet Activity
   As a class, students will look at a visual that comes from the Pew Research Center. This data is from a phone survey that was collected between January and February 2019. In total, the data represents a sample of 1,502 U.S. adults aged 18+, with 302 answering from a landline and 1,200 answering from their cell phone. Students will discuss as a class what they see and share their thoughts on what they think of the data or what could have affected the results. From here, students will look at the data in a spreadsheet and discuss things like how the data is organized, what do they notice about the spreadsheet, are there any ethical questions raised by this data, etc. Students will be put into groups to think about what questions they could ask about the data or how they could update it with questions about social media etc.
6. Introduction to CODAP Program
   Students will use the Pew Data Investigation to help introduce CODAP to students. CODAP is a tool students will use to help create visuals/models to study. Students will open up a file already made of the Pew Data and play around with the program for a few minutes. The class will reconvene and discuss what the students found and what questions they have. Some questions will be answered now, while others will be answered in later units.
7. Me & The Bees Project
   Earlier students used data to tell their own stories and to find patterns in other people's data. Now, students are going to make sense of how data is used in business to make decisions. Students will start by watching the Me & the Bees video. Students will be creating a business report for Me & the Bees. They will be given data to explore, model (find patterns within), and analyze. Finally, they will write a report to communicate their findings and describe recommendations for the company to better understand and improve their business.

Resources:

- YouCubed
- Dear Data by Giorgia Lupi and Stefanie Posavec
- Online Tool CODAP
- Me & the Bees Video
- Microsoft Excel or Google Sheets
- Pew Data from Pew Research Center website

Unit Modifications for Special Population Students	
Advanced Learners	Lead class discussions/Data Talks Create scenarios/provide examples for class to investigate Provide alternate views for Data Ethics
Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
English Language Learners	Provide ELL students with multiple literacy strategies as needed; (for example, alternate response, advance notes, extended time, teacher modeling, simplification of written and verbal instruction, frequent breaks, eDictionaries). http://www.state.nj.us/education/modelcurriculum/ela/ELLSupport.pdf
Special Needs Learners	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process, or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Indicators:

Computer Science

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

ELA

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Science

HS-PS1-7: Use mathematical representations of phenomena to support claims.

HSPS1-3: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly

HS-PS2-1: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, critical thinking, and creativity.

Unit Title: Data of our Community

Unit Description: Students will explore different ways of modeling data, starting with the basic models of measures of center and spread, as well as considering sampling. Students may already be familiar with some of the calculations needed to find measures of center and spread for small data sets, but this unit takes a deeper dive into understanding the concepts, deeper meanings, limitations, and the impact of outliers in the context of data modeling. Students will also collect their own data and compare it to a larger data set. During the project, students will consider their sampling choices and those of the larger data set to see how such decisions impact the comparisons drawn between the two data sets.

Unit Duration: Approximately 5 Weeks

Desired Results

Standard(s):
HSS-ID.A: Summarize, represent, and interpret data on a single count or measurement variable

HSS-ID.B: Summarize, represent, and interpret data on two categorical and quantitative variables

HSS-IC.B: Make inferences and justify conclusions from sample surveys, experiments, and observational studies

Indicators:
Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets

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.

Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

Understandings:
Students will understand that…

- There are many different ways to model data.
- They may have learned some of the calculations from previous math classes but called it by a different name. They are familiar with the terms mean, median and mode. These are called "Measures of Center."
- Center is the median and/or mean of the data.
- Spread is the range of the data.
- Shape is the type of graph.
- Univariate data is looking at data with only one variable.
- Numerical data would be responses to questions where respondents type in a number for their response.
- Categorical data would be data where participants choose from a list of options in response to questions.
- It is important to take time to create good questions that will help collect data. This is the

Essential Questions:

- What are some different ways data can be modeled?
- How do you calculate measures of center and spread? How is this similar to something from a previous math class?
- What are outliers? How do they effect data?
- How can data be collected?
- How would you record the data collected?
- What is univariate data?
- Compare the differences between numerical and categorical data. Use examples as part of your explanation.

"Ask Questions" part of the Data Science Process. Students may come up with a few questions at first, but then realize that they can refine them to get clearer data they need.	

Assessment Evidence

Performance Tasks:

Students will be able to…

- Discuss measures of center, spread and shape in univariate data.
- Explore and discuss as a class the ACS data process.
- Distinguish the difference between numerical and categorical data.
- Discuss the different components of a box plot.
- Communicate their results by sharing their reasoning, conjecture, summary statistics, and story of their variable.
- Consider what questions to ask of their community and design a survey to collect data using Google/Microsoft Forms.
- Discuss the limitations of summary statistics.
- Create histograms that represent weights usage.
- Explain standard deviation and explore attributes of normal distributions.
- Investigate the community dataset, identify any irregularities, and discuss how to perform required cleaning.
- Discuss what is sampling and the pros and cons of using samples.

Other Evidence:

- Class discussions
- Independent Work
- Group Work
- Weekly Reflections
- Projects
- Data Talks
- Survey Questions

Benchmarks:

Class Discussions/Data Talks
Measures of Center Presentation
Design a Survey and Data Collection
Histogram of the Weights Visual Activity

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. Measures of Univariate Data
   The focus for this unit will only be on Univariate Data (one variable). Students may know the measures of center from previous math classes, just under different names (mean, median, mode, range). Students will review these to make sure they remember how to calculate them. Finding and talking about these measures of center will reoccur throughout this unit/year.
3. Box Plot Activity
   Students will learn about the different parts of a box plot and how it can be used to create/tell the story of the data. The box plot abstracts some details away, but it gives a quick summary that, while not comprehensive, allows students to get a sense of what the data looks like and compare it to other data sets more easily.
4. Histogram of Weights
   Looking at the given picture, students can create a histogram of weight usage. Students will look for clues in the picture to help sketch their histogram. This will introduce the students to normal distribution.
5. American Community Survey Activity
   Students will start by discussing what they know about the American census. They will explore videos detailing more information about the census. This activity will help students narrow down the questions they might want to ask for data in the survey activity they will be doing later in the unit. Students will start by splitting into two groups and look at the ACS dataset from California. On CODAP, one group will explore the CA individual data and another group will explore the CA household data. Both groups will exchange information and hope to narrow down questions they will pick. From this, in groups, students choose a state (Alabama, Alaska, Hawaii, Iowa, Massachusetts, New Mexico, or Oregon) and a variable from the ACS dataset to explore in Google Sheets/Microsoft Excel using the data science process. Groups create a Google Slideshow/Power Point to share their story of the state and variable. Discuss Sampling and its importance.
6. Design a Survey
   As a class, students will create a survey with a subset of the ACS questions and collect data from family and friends in their local community. They will then decide as a class which questions they want to ask in their survey. Create a Google/Microsoft Form and have a paper version as well. Students will then be tasked with going around the school and home asking people to complete the survey or record their responses.
7. Cleaning Data Activity
   Students are now on the “Gathering and Organizing Date” step of the process. To do this, the class needs to clean up the data students have gathered. As a class, students will discuss what to keep, what to get rid of, outliers, etc. Once the class has cleaned up the data, they will compare it with the state they picked in the ACS activity. Groups will present their findings to the class.

Resources:

- YouCubed
- American Community Survey
- Online Tool CODAP
- Microsoft Excel or Google Sheets
- Microsoft/Google Forms
- Google Collab

Unit Modifications for Special Population Students	
Advanced Learners	Lead class discussions/Data Talks Lead groups in collecting data for surveys. Pick two variables for their survey instead of one.

Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
English Language Learners	Provide ELL students with multiple literacy strategies as needed; (for example, alternate response, advance notes, extended time, teacher modeling, simplification of written and verbal instruction, frequent breaks, eDictionaries). http://www.state.nj.us/education/modelcurriculum/ela/ELLSupport.pdf
Special Needs Learners	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process, or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
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Interdisciplinary Connections

Indicators:

Computer Science

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

9.4.12.O.11: Apply active listening skills to obtain and clarify information.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

ELA

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

WHST.11-12.1.B: Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Science
HS-PS1-7: Use mathematical representations of phenomena to support claims.

HSPS1-3: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly

HS-PS2-1: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, critical thinking, and creativity.

Unit Title: Water in our Life

Unit Description: In this unit, students will learn about bivariate data through discussions and data explorations around the theme of water usage. Students will explore scatter plots as a visual way to represent the relationship between two variables, draw their own lines of best fit, and learn how data scientists determine and analyze lines of best fit. Students will be using tools such as Google Sheets/Excel, and CODAP to make and refine claims about water usage based on data they collect and public data sets.

Unit Duration: Approximately 5 Weeks

Desired Results

Standard(s):
HSS-ID.B: Summarize, represent, and interpret data on two categorical and quantitative variables.

HSS-ID.C: Interpret Linear Models.

Indicators:
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.

Represent data on two quantitative variables on a scatter plot and describe how the variables are related.

Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data.

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Compute (using technology) and interpret the correlation coefficient of a linear fit.

Distinguish between correlation and causation

Understandings:	**Essential Questions:**
Students will understand that… • Bivariate data is data for two variables. Each value of one of the variables is paired with a value of the other variable • Water usage can vary depending on numerous things such as location, living environment, etc.	• What is data and what is it good for? • Hypothesize what students can do with data. • What is bivariate data? • Estimate/construct a line of best fit. • How can students use technology to create a line of best fit? • Investigate things that can effect water usage.

• It is possible to draw an estimated line of best fit, but technology can help create a more accurate one. • Students can use the least squares line for better accuracy because it minimizes variance in data. • A spurious correlation in statistics represents a connection between two variables that seems to be a causal relationship but really is not. A causal relationship (causation) describes a cause-and-effect relationship between two variables where one variable does something that directly affects the other. Spurious correlation can occur either randomly or because there is a confounding variable. • A confounding variable is a third variable that influences both the independent (cause) and dependent (effect) variables. • A Mediating variable is different from confounding variable because supports spurious correlation and leads to causation.	• What is Least Squares Line? • What is the difference between Spurious Correlation and Causation? • Describe the difference between random and confounding variables? • What are mediating variables?

Assessment Evidence	
Performance Tasks: *Students will be able to…* • Explore the features of a scatter plot and understand the meaning of bivariate data and the line of best fit. • Analyze a scatter plot and approximate a line of best fit using CODAP. • Analyze residuals and squares of residuals to determine how well a line fits the data. After, students will use CODAP. • Fit a linear function on a scatter plot using CODAP. Students will identify potential outliers in a scatter plot. • Compare lines of best fit and squares of residuals across different data sets using CODAP. • Use CODAP to compare R^2 values and make a connection between R^2 and correlation. • Identify Spurious correlations and distinguish between confounding and mediating variables. • Gather observations and evidence about data visuals to write claims and tell stories. • Investigate correlation, causation, and third variables.	**Other Evidence:** • Class discussions • Independent Work • Group Work • Weekly Reflections • Projects • Data Talks • CODAP

Benchmarks:

Class Discussions/Data Talks
Water Usage Project
Line of Best Fit Activity
Least Squares Line
Comparing Data with CODAP
Correlation vs Causation Activity
Vocab Assignment

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. Water in your life activity
   This activity will take place over several days. Students will be gathering data about their water usage in their daily lives. They will start by asking/answering questions such as why water usage matters, what conversations about water have they have had at home, etc. The hope is that these conversations will help students to begin to understand the importance of water usage in their day to day lives and feel connected with the problems they will investigate over the course of the unit. After initial conversation (asking questions phase), students will be moving on to the gathering data phase of the data science process. This will require students to brainstorm about what water is used for in their homes. Students will be required to collect data on their water usage. Students will use this website to keep track. Students will learn that they are collecting this bivariate data to see if there is a relationship between the two variables: number of gallons used and how many people are in a household. Once students have collected data over several days, they will analyze as a class what the results are. From here, students will move on to the modeling and analyzing phase. Students could graph this data by hand to create a visual, but there are many tools they will be learning in this course that will allow them to use technology to look at data. This technology can help students to see the relationships in bivariate data. Students will be using CODAP and Excel to help with this. With the data graphed, the class will use a moveable line that best represents the data. This will lead students into a discussion about line of best fit, which is another activity which will be completed in this unit. Students will come back at the end of the unit to revise some of the statements based on knowledge gained over the next few weeks.
3. Line of Best Fit Activity
   This will build off of the water activity. Students will start with a warmup where they have to figure out how to mathematically calculate the line of best fit, and how well it fits the data. Students may have different approaches to comparing the actual points of the data to the estimated line of best fit. This is okay, because in math, there are always more than one way to approach a problem. This will lead them to discuss how error can be measured with the line of best fit. A new term will be introduced, residual, and students will learn how to calculate it. The ultimate goal will be to minimize the error between data and the model. Students will turn on the squares of residuals in CODAP and move around the line of best fit. Students will observe how the size of the squares can help show if the line of best fit is a good fit.
4. Least Square Lines
   Students will learn that the line with the smallest overall sum of areas is also called the least squares line. One common way to compute the line of best fit is the least squares line, which is the strategy students focus on in this course. Students will learn how to use this in CODAP. As a class, students will discuss that functions are used to model the data in order to answer questions about the data. When a function models the data well, students can predict that additional data points would also be located near the function. There are many different functions students can choose from: linear, exponential, logarithmic, etc. Sometimes these functions fit the data closely and other times they don't. The goal is to choose a model so that the error is minimized.

5. Comparing Data with CODAP
   For this, students will be focusing on the R^2 value in CODAP. Students will make conjectures on how they think the R^2 value is related to the line of best fit and the data. Students can use this to talk about strong correlations and weak correlations. The class will learn that r is called the correlation coefficient. There are multiple ways of calculating it, but it tells how strong the correlation is between the two variables.
6. Correlation vs Causation
   Students will be introduced to the concepts of spurious correlation and causation (causal relationship) and the differences explored. There will be visual examples and videos for students to use to help understand the difference. This will lead into talking about confounding variables and how it makes the variables seem related when they are not. The class will then split into groups and compare four different graphs. Their goal is to see if each graph is either correlation or causation, or if there may be a confounding or mediating variable involved.

Resources:

- YouCubed
- Online Tool CODAP
- Microsoft Excel or Google Sheets
- Microsoft/Google Forms
- Water Science Questionnaire
- How Ice Cream Kills! Video
- Correlation vs Causality Video

Unit Modifications for Special Population Students	
Advanced Learners	Lead class discussions/Data Talks Lead groups in activities Explain to group/class the findings they have in the explorations. Create their own examples of correlation vs causation.
Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
English Language Learners	Provide ELL students with multiple literacy strategies as needed; (for example, alternate response, advance notes, extended time, teacher modeling, simplification of written and verbal instruction, frequent breaks, eDictionaries). http://www.state.nj.us/education/modelcurriculum/ela/ELLSupport.pdf
Special Needs Learners	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process, or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections
Indicators: **Computer Science** **8.1.12.DA.1**: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. **8.1.12.DA.5**: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. **8.2.12.EC.3**: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

ELA

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text

RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Science

HS-PS1-7: Use mathematical representations of phenomena to support claims.

HSPS1-3: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly

HS-PS2-1: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, critical thinking, and communication.

Unit Title: Shuffling Songs

Unit Description:
In this unit, students will again consider the modeling process and the role played by variation, reflecting on the data collected from simulations and the ways data can help answer probabilistic questions and leverage this power for decision-making. In the process of creating powerful simulations, students will learn the basics of programming, which will continue to be a powerful tool for data analysis. For coding, students will be using EduBlocks.

Unit Duration: Approximately 5 Weeks

Desired Results

Standard(s):

HSS-CP.A: Understand independence and conditional probability and use them to interpret data.

HSS-IC.A: Understand and evaluate random processes underlying statistical experiments

HSS-MD.A: Calculate expected values and use them to solve problems

Indicators:

Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.

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.

Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations

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.

Understandings:
Students will understand that…

- Algorithmic thinking is creating a set of ordered steps and then doing them in a particular order to solve a problem or accomplish a task in a way that could be repeated by others aka using an algorithm.
- A loop is a sequence of instructions that is continually repeated until a certain condition is reached.
- If-Then statements are also known as Conditional statements. The hypothesis is the first part, and the conclusion is the second part. “If this happens, then that will happen.”
- Theoretical Probability is calculating the probability of it happening, not actually going out and experimenting.
- Experimental Probability is probability that is determined or calculated through experiments, direct observation, experience, practice, etc.

Essential Questions:

- What is Algorithmic Thinking?
- What are loops?
- Describe the process of If-Then Statements
- What is the difference between Theoretical and Experimental Probability?
- What is Conditional Probability?
- Do the genres you hear played on shuffle represent the genres of the songs in the class playlist?

• Conditional probability is probability of an event or outcome occurring based on previous events or outcomes.	

Assessment Evidence	
Performance Tasks: *Students will be able to:* • Discuss the difference between theoretical and experimental probability. • Gather and organize a class spreadsheet of songs with associated genres using Google/Microsoft Forms and Sheets/Excel. • Explore and discuss different strategies they can employ to calculate theoretical probabilities in a dataset. • Simulate playing songs from the class playlist and compare the theoretical and experimental probabilities. • Explore the Law of Large Numbers by compiling playlists and recalculating the experimental probabilities. • Investigate important features of coding by comparing programs that appear strikingly similar. • Learn the structures of for loops and how to append lists by examining and discussing the purpose of programs. • Learn the structures of if-else statements by examining the outputs of a program and brainstorming its code. • Write pseudocode to decompose the larger goal into smaller tasks. • Program a song shuffle simulation in EduBlocks. • Check their completed code for any bugs and determine the reasonableness of the repeated output. • Visualize and calculate conditional probabilities of shuffling the class music playlist by using tree diagrams.	**Other Evidence:** • Class discussions • Independent Work • Group Work • Weekly Reflections • Projects • Data Talks • CODAP

Benchmarks:

Class Discussions/Data Talks
Song Shuffle Simulation
Creating Class Playlist/Cleaning the Data
Basics of Programming Activity/Project
Theoretical Vs Experimental Probability Activity
Conditional Trees

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. Create Class Playlist
   Students are going to create a class playlist and identify the genre categories the songs are in. The class will use the resulting Song List and Genre List for the simulation. The goal is to represent 4-6 different genres in the class playlist. Students will keep it to 4-6 in order to make the probabilities more meaningful and to create a program that isn't too unruly. If needed, genre categories can be created for the playlist more specific or less specific. In this part of the project, students are in the gathering and organizing data step of the data science process. Students will work with a partner to brainstorm a list of 10 songs to add to the class playlist. Once pairs have their lists of songs and genres, the class will gather and share what they have created. The class will definitely have to consolidate the list. Students will then compile their data into a Microsoft Form to create a spreadsheet of the playlist. Students will then have to work to clean up the data (delete duplicates, formatting, etc.). Once the data is cleaned up, students will reflect on the data collection and cleaning process.
3. Theoretical vs Experimental Probability
   Students are going to consider the theoretical probability (the likelihood of each genre being played) and compare that to experimental probability (the songs/genres that are actually played). They will work with their group to calculate the theoretical probability of each genre to answer the question, what is the likelihood of a song of each genre being played? After a few minutes, students will be questioned to provide how they calculated the probability for each genre and which genre is most likely to be played. In the next part of the activity, students will simulate the playlist on shuffle in sheets to gather data on the experimental probability of which genres of songs actually get played. To do this, students will 'play' music on shuffle from the class playlist and see how often each genre category actually plays. Students will then consider how close that comes to the distribution of genre categories from the actual playlist. Instead of actually playing the music though, students will use a random number generator to pull random songs from the spreadsheet. Groups will record their own experimental data, and then the class will meet back to discuss their results. Students will learn that the more often an experiment is conducted, the closer the experimental and theoretical probabilities get. This concept is called Law of Large Numbers.
4. Basics of Programming
   The class will be introduced to the basics of programming using EduBlocks (Python). EduBlocks is "block programming." Some students are very fearful of coding, and this block programming is a great way to break that wall. Students will follow a handout and explore different parts of EduBlocks. As they explore, questions will be documented on the board and addressed. However, some questions will be answered at a later time. To help students keep track of what they learn with programming, a running word document will be created. This "Programming Reference" sheet will be updated as students move through the year. This way students can always refer back to it when needed.
   Students will be spending the next few classes learning:
   - Establish variables and the print function
   - Variable types and + symbol

- Lists, indexing and randomness
- For loops, +=
- Interpreting outputs
- If-else statements

5. Song Shuffle Simulation
   Students will revisit the class playlist created at the beginning of the unit and program a model that allows them to answer the unit question: Do the genres you hear played on shuffle represent the genres of the songs in the class playlist? First, they will write their program in EduBlocks using a small list of songs and their corresponding genres. Then, students will move their code from EduBlocks into Colab by utilizing the Python code that EduBlocks generates from their block coding and apply their model to the whole class playlist. As students work through programming in EduBlocks, they should keep in mind that their program will eventually need to run not just on the provided small data set, but also on the whole class playlist when it is moved to Colab. This requires some careful consistencies in variable and list names. This will take several class periods to work on and complete.
6. Conditional Trees
   Students will be exploring conditional probability about their song shuffle simulation without replacement (If songs are shuffled from the class playlist without replacement, what is the probability of a rock song playing second if the first song was a rock song?). To help visualize this, students will use conditional trees. They will start with a very broad one, but soon realize it is way too much work and need to clean it up to make it easier to work with. With the smaller, more condensed tree, students can begin to calculate the probabilities of each branch.

Resources:

- YouCubed
- EduBlocks
- Collab
- Microsoft Excel or Google Sheets
- Microsoft/Google Forms
- YouTube Videos

Unit Modifications for Special Population Students	
Advanced Learners	Lead class discussions/Data Talks Lead groups in activities Explore and lead class in EduBlocks Try different coding languages on own. Experiment with different functions in coding.
Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
English Language Learners	Provide ELL students with multiple literacy strategies as needed; (for example, alternate response, advance notes, extended time, teacher modeling, simplification of written and verbal instruction, frequent breaks, eDictionaries). http://www.state.nj.us/education/modelcurriculum/ela/ELLSupport.pdf
Special Needs Learners	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include:

	• Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process, or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Indicators:

Computer Science

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

9.4.12.O.(1).8: Select and use a range of communications technologies, including word processing, spreadsheet, database, presentation, email, and Internet applications to locate and display information.

9.4.12.O.(2).5: Demonstrate critical thinking abilities and skills needed to review information, to explain statistical analyses, and to translate, interpret, and summarize research and statistical data collected and analyzed as the result of an investigation.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

ELA

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text

RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

WHST.9-10.6. Use technology, including the Internet, to produce, share, and update writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Science

HS-PS1-7: Use mathematical representations of phenomena to support claims.

HSPS1-3: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly

HS-PS2-1: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, critical thinking, and communication.

Unit Title: What's the Best Place for Me?

Unit Description:
For this unit, students will build a prioritization model to create a ranking. In this process, students will decide what they value, collect variables based on their values, gather and clean data, create functions to combine variables, normalize data, and create a weighting system for prioritizing their data. Students will do a sensitivity analysis on their weighting system. During this process, students will discuss how bias impacts mathematical models. They will use reasoning, justifications, and visualizations to explain their decisions.

Unit Duration: Approximately 5 Weeks

Desired Results

Standard(s):

HSS-ID.C: Interpret Linear Models

HSF-LE.A: Construct and compare linear and exponential models and solve problems

Indicators:

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Apply mathematics to solve problems arising in everyday life, society, and the workplace.

Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.

Understandings:
Students will understand that…

- The Human Development Index (HDI) was created as a way to measure and compare countries' development beyond economic development. The report is used by policy makers and world leaders to compare, evaluate, and question a country's policies.
- Bias is a disproportionate weight in favor of or against an idea or thing.

Essential Questions:

- What is bias? How can bias effect data/gathering data?
- What are statistical biases?
- What is sensitivity analysis?
- What is HDI?
- What are dimensions in terms of data science?
- What is the Data Commons API?

• Statistical biases can be broken down into social desirability bias, Survivorship bias, Selection bias, Volunteer bias, Funding bias, Recall bias, Omitted variable bias, Nonresponse bias, and Reporting bias. • Dimensions is another way of saying characteristics. • Sensitivity analysis is a common process performed regularly by data scientists to follow once a model is completed. The name comes from the idea of seeing how "sensitive" the model is to different changes, meaning if a change is made to the model what will its impact be on the model. It provides students the opportunity to understand the relationships between the inputs and outputs of a model, simplify the model, and find errors. • Data Commons API (Application Programming Interface) is the system Google uses to pull variables from Data Commons into Google Sheets.	

Assessment Evidence	
Performance Tasks: *Students will be able to…* • Explore the HDI and investigate its underlying principle to discuss its (mis)alignment to students' values. • Brainstorm potential dimensions for their city ranking model • Determine dimensions and indicators/variables or proxy variables that they will use in their ranking. • Investigate different types of biases and discuss what steps of the Data Science Process each bias might affect. • Explore using Data Commons API in Google Sheets to pull the indicators/variables for their ranking model. • Discuss what indicators/variables to use and how to manipulate them to create an index for each of their dimensions. • Normalize their data so that their indices are all on the same scale and combine their indices to create a ranking. • Examine the results that their model is producing and explore the sensitivity of their model to changes in their weighting. • Share and receive feedback on their ranking model by pairing with another group. • Work in groups to create a deliverable (article, presentation, or video) to share their ranking list.	**Other Evidence:** • Class discussions • Independent Work • Group Work • Weekly Reflections • Projects • Data Talks • CODAP • Presentations

• Present their group final project to the class and take up questions and comments from the audience. • Write a project reflection and consider how their rankings and model may have introduced biases.	

Benchmarks:

Class Discussions/Data Talks
City Ranking Project
Statistical Biases Group Presentations

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. City Ranking Project
   In this project, groups will work through the data science process considering the question "Where might I want to live based on what I value?" Each group will create a list of what is most important to them and then use these key dimensions along with Data Commons and Google Sheets/Excel to gather, model and analyze data to come up with a list of the top 5 cities to live based on the group's priorities. Each group will choose between an article, video, or presentation to communicate their ranking. Individually, students will do a final write up. To help students along the way, they will work together as a class on certain things such as deciding which dimensions are important (need to narrow down to 3-5), how to explore and use information from the Data Commons, how to represent dimensions with data, normalize data, and create a ranking model for that data. Students will complete examples together as a class of each item, and students will take what they learn to apply to their own projects. This project will take several class periods to complete.
3. Statistical Biases Group Presentations
   This assignment will take place in the middle of the City Ranking Project. As a class, students will start by discussing what bias means, and where they might see it/use it. Students will then be introduced to Statistical biases, which are not as well-known. In groups, students will pick 1-2 biases from a list of statistical biases (Social desirability bias, Survivorship bias, Selection bias, Volunteer bias, Funding bias, Recall bias, Omitted variable bias, Nonresponse bias, and Reporting bias). Groups will research the bias they choose. In their presentation they should add a definition of the bias in their own words, what steps of the data science process this bias might affect, and an example of the bias. Groups will talk through their presentation, explaining their bias to the rest of the class. Students will be encouraged to ask questions and connect biases to one another. The class will wrap up by discussing "What can we do to prevent these biases from affecting our work?"

Resources:
Human Development Index
Data Commons from Google
YouCubed

Unit Modifications for Special Population Students

Advanced Learners	Lead class discussions/Data Talks Lead groups in activities Pick more than 1 Statistical Bias to present Research statistical biases not discussed in class Use more than 5 dimensions when comparing city ranks
Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
English Language Learners	Provide ELL students with multiple literacy strategies as needed; (for example, alternate response, advance notes, extended time, teacher modeling, simplification of written and verbal instruction, frequent breaks, eDictionaries). http://www.state.nj.us/education/modelcurriculum/ela/ELLSupport.pdf
Special Needs Learners	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process, or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
Learners with a 504	Refer to page four in the Parent and Educator Resource Guide to Section 504 to assist in the development of appropriate plans.

Interdisciplinary Connections

Indicators:

Computer Science

9.4.12.O.27: Employ spreadsheet applications to organize and manipulate data.

9.4.12.O.32: Effectively use information technology to gather, store and communicate data in appropriate formats.

9.4.12.O.(1).8: Select and use a range of communications technologies, including word processing, spreadsheet, database, presentation, email, and Internet applications to locate and display information.

9.4.12.O.(2).5: Demonstrate critical thinking abilities and skills needed to review information, to explain statistical analyses, and to translate, interpret, and summarize research and statistical data collected and analyzed as the result of an investigation.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

ELA
RST.11-12.3. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.6. Use technology, including the Internet, to produce, share, and update writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Science
HS-PS1-7: Use mathematical representations of phenomena to support claims.

HSPS1-3: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly

HS-PS2-1: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, critical thinking, and communication.

Unit Title: Predicting my Preferences

Unit Description:
In this unit, students will be introduced to the big ideas behind machine learning. They will build two different machine learning algorithms to make predictions on whether they will like a song. In this process they will learn about using vectors and matrices as data structures as well as applying conditional probability and exercising their basic programming abilities. Students will also consider how machine learning impacts their lives and others' lives and will share their newly gained understandings of machine learning with a member of their community.

Unit Duration: Approximately 5 weeks

Desired Results

Standard(s):
HSS-ID.C: Interpret Linear Models

HSF-LE.A: Construct and compare linear and exponential models and solve problems

Indicators:

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Apply mathematics to solve problems arising in everyday life, society, and the workplace.

Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.

Understandings:
Students will understand that…

- An algorithm is a step-by-step procedure for solving a problem, making something, or doing something.
- Marching learning involves feeding the computer data so that it can find patterns to create a model. Machine learning algorithms use data and answers to estimate the algorithm. This is a powerful tool that allows us to make predictions. Machine learning is a very new technology, which means it is changing and improving constantly.
- Content based filtering considers the features of the content and the users' patterns to recommend similar content.
- Collaborative filtering method takes a look at how similar other users are and combines that along with the preferences of those users to make recommendations.
- In data science, vectors are used to represent multivariable information.

Essential Questions:

- What is an algorithm?
- Compare and contrast content based filtering and collaborative filtering.
- What is machine learning? Describe the pros and cons of machine learning. Use examples as part of the comparison.
- What are vectors and how can they be used to store data?

Assessment Evidence

Performance Tasks:
Students will be able to…

- Write an algorithm to make a sandwich via trial and error.

Other Evidence:

- Class discussions
- Independent Work
- Group Work
- Weekly Reflections

• Determine the difference between content based filtering and collaborative filtering. • Discuss content-based filtering in the context of music and brainstorm what makes songs similar. • Define how vectors can be used as a way to store data and demonstrate how to represent them graphically. • Explain how data sets are split into training and testing data to create a model in machine learning. • Explore models with increasing complexity to understand the outcomes of increasing the level of complexity. • Explore the importance of finding the level of complexity that will lead to better predictions of future data. • Build a 1-3 attribute model to predict song ratings and test the accuracy of their model. • Discuss and summarize their learning of content-based filtering and how they made their decisions for their model. • Consider how to calculate the conditional probability of one person liking a particular song, given another person likes that same song. • Edit code in EduBlocks to create a function and transfer this code to the collaborative filtering Colab notebook. • Discuss how they can use the conditional probability and ratings vectors to predict ratings for a new song. • Consider the impact of machine learning algorithms in their lives by learning about two current ethical issues.	• Projects • Data Talks • CODAP • Presentations

Benchmarks:

How to Make a Sandwich Assignment
Music and Machine Learning Project
Method Flowchart Assignment
Building 1-3 Attribute Models Assignment
Create Person Likes Song Code
Data Ethics Assignment

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. How to Make a Sandwich Assignment
   This assignment will help introduce students to the definition of an algorithm. Students will work in groups to write step-by-step instructions for making a peanut butter and jelly sandwich. After a set amount of time, a volunteer group's instructions will be used to make a sandwich. Students may begin to see that they forgot some basic steps they might have overlooked. Students will then have time to revise and edit their instructions. Students will repeat this process until they can create a sandwich.
3. Method Flowchart Assignment
   In this activity, students will work in groups and consider when an app/video has recommended something to them. They will discuss what they think the app did to make the recommendation considering what they have learned so far about content and collaborative filtering methods. Groups will then create a method flowchart to visually communicate what they discuss. Once all groups have had time to complete the activity, they will do a gallery walk to see other groups visuals. Students will regroup as a class and discuss their findings. The goal at the end is for students to have a conceptual understanding of the two types of filtering and how they differ.
4. Music and Machine Learning Project
   This unit's project will have students creating a presentation demonstrating their understandings and critiques about machine learning. This presentation will be created over the course of the unit to share what students learn about building music recommender systems. The first part of the presentation will be their summary of what machine learning is and sharing examples of how it is used. They should be sure to include content based and collaborative filtering as well. The next part of the presentation will be the three different models and their predictions they made during the unit. Students will discuss their reflections and learning on content-based filtering. The third part will be students sharing their decisions when creating their collaborative filtering model and resulting predictions. They will need to share their function code they wrote, pictures of their conditional probability calculations, matrices they made, probability vectors they created and discuss their results. The fourth part will require students to share their reflections and take aways about how the two filtering methods compare. The final part of the presentation will have students share their thoughts about ethics of machine learning.
5. Building 1-3 Attribute Models Assignment
   With a partner, students will build models to predict their ratings for songs based on attributes they pick. They will start by building a one-attribute model, then two, and then three. They will be modeling the data, deciding on the best level of complexity for the model, and then use that model to make predictions. Each student will run the collab program individually, provide their individual song ratings and attributes of their choice, and decide on the level of complexity for their model. They will refer to their partners for help and feedback. This will be included in the Music and Machine Learning Project.
6. Create Person Likes Song Code
   Students will be taking starter code and editing it to their needs. The code they will be editing represents a section of code meant to carry out a specific task within a program (a function). A function in code is similar to a function in mathematics where it intakes some type of input, applies an algorithm to it, and then returns an output. In this case, the first line of code defines the new function to be called person_likes_song and to accept as inputs song_rating and measures_of_spread. What students want is for this person_likes_song function to take the song_rating input and to (perhaps using the measures of center of the user's other song ratings) decide whether or not that rating means the person liked the song or not. This will be included in the Music and Machine Learning Project.
7. Data Ethics Assignment
   To wrap up this unit, students will consider the impact of machine learning algorithms in their lives. As a class, students will watch a few videos about current ethical issues that involve machine learning. After each video, students will share their initial impressions. After the videos students will work in groups for a jigsaw reading of several machine learning articles. Once students have spent time

discussing their different articles in their jigsaw groups, they will regroup as a class and discuss their thoughts. This will be included in the Music and Machine Learning Project.

Resources:
YouCubed
YouTube Videos
EduBlocks
Do Digital Echo Chambers Exist (BBC Article)
Echo chambers are dangerous – we must try to break free of our online bubbles (The Guardian)
Should We Be Afraid of AI in the Criminal-Justice System? (The Atlantic)
Predictive policing algorithms are racist. They need to be dismantled. (MIT Technology Review)

Unit Modifications for Special Population Students	
Advanced Learners	Lead class discussions/Data Talks Lead groups in activities Make an algorithm for a different type of sandwich Complete coding segment Debate different views of ethics of machine learning
Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
English Language Learners	Provide ELL students with multiple literacy strategies as needed; (for example, alternate response, advance notes, extended time, teacher modeling, simplification of written and verbal instruction, frequent breaks, eDictionaries). http://www.state.nj.us/education/modelcurriculum/ela/ELLSupport.pdf
Special Needs Learners	Each special education student has in Individualized Educational Plan (IEP) that details the specific accommodations, modifications, services, and support needed to level the playing field. This will enable that student to access the curriculum to the greatest extent possible in the least restrictive environment. These include: • Variation of time: adapting the time allotted for learning, task completion, or testing • Variation of input: adapting the way instruction is delivered • Variation of output: adapting how a student can respond to instruction • Variation of size: adapting the number of items the student is expected to complete • Modifying the content, process, or product Additional resources are outlined to facilitate appropriate behavior and increase student engagement. The most frequently used modifications and accommodations can be viewed here. Teachers are encouraged to use the Understanding by Design Learning Guidelines (UDL). These guidelines offer a set of concrete suggestions that can be applied to any discipline to ensure that all learners can access and participate in learning opportunities. The framework can be viewed here www.udlguidelines.cast.org
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Interdisciplinary Connections

Indicators:

Computer Science

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9.4.12.O.(1).8: Select and use a range of communications technologies, including word processing, spreadsheet, database, presentation, email, and Internet applications to locate and display information.

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9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

ELA

RST.11-12.3. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
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Science

HS-PS1-7: Use mathematical representations of phenomena to support claims.

HSPS1-3: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly

HS-PS2-1: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, critical thinking, and communication.

Unit Title: Being a Data Scientist

Unit Description:
This unit will bring together all that the students have been working on. Students will have an opportunity to work through the full cycle of data science: making their own decisions about the questions they are interested in exploring, finding data to answer that question, cleaning the data, creating, and analyzing a model, communicating with the data visually and reflecting on their process. This will be an iterative process mirroring how data scientists work on a project. Students will gather their own data. They will make decisions about how to work with it and describe the choices they have made including what technology tools to use, cleaning moves, visualization selection, univariate, or bivariate data choices, combining data, and other content relevant to their project of choice.

Unit Duration: Approximately 5 Weeks

Desired Results

Standard(s):
HSS-ID.C: Interpret Linear Models

HSF-LE.A: Construct and compare linear and exponential models and solve problems

Indicators:

Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Apply mathematics to solve problems arising in everyday life, society, and the workplace.

Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.

Understandings:	**Essential Questions:**
Students will understand that… • The Data Science Process is used to help us effectively record data, model it, analyze it, and communicate results. There are five major steps: Ask Questions, Gather and Organize Data, Model, Analyze and Synthesize, and Communicate Results. • Data Science enables us to efficiently understand gigantic data from multiple sources	• What is the data science process? How would you use it in a real-life scenario? • Why is Data Science important? • What are key tools/technologies used throughout the school year? • What are you going to do for the final project?

and derive valuable insights to make smarter data-driven decisions. Data Science is widely used in various industry domains, including marketing, healthcare, finance, banking, policy work, and more.
- Tools and technologies are used to help gather, store and model data. Some things used throughout the year include Google Sheets/Excel, Google Collab, CODAP, Google/Microsoft Forms, EduBlocks, and Tableau.
- Students will need to use their portfolio and everything they have learned in this past year to complete their final project.

Assessment Evidence

Performance Tasks:

Students will be able to…

- Review their learning from the course by exploring their portfolio and reflecting on their work and areas for growth.
- Read through the project description, look at the rubric and brainstorm project ideas.
- Consider the data they wish to use/collect for their project.
- Participate in peer feedback to present their project proposal and make revisions.
- Submit their project proposal for teacher evaluation. Once approved students will begin working on their project.
- Record goals and questions for the day to make progress on their final project using their peers as resources. There will be weekly check ins where students must be at a certain point in their project.
- Present their project drafts in groups and give specific feedback using the Project Criteria and Feedback Rubric.
- Present their final project to the class and provide feedback on either the project content or the data science approach.
- Discuss their learning, challenges, and interests as a class and reflect on the course individually in writing.

Other Evidence:

- Class discussions
- Independent Work
- Group Work
- Weekly Reflections
- Projects
- Data Talks
- CODAP
- Presentations

Benchmarks:

Being a Data Scientist Final Project
Project Proposal
Project Peer Feedback
Weekly Check Ins (Project Tracker)
Project Reflection

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. Project Proposal
   In this proposal students will choose a topic and begin to think through creating their question, where and how they will gather data, how they will model the data and what technology they might use to model the data, what their analysis might look like and how they will communicate their findings. Students will provide responses to all of these questions, but their responses to questions one and two should be more detailed at this point than the others. Students may revise this document as they work on their project. They will run a proposal draft to another students, make revisions if necessary, and then submit it to the teacher for final approval. Once their project proposal is approved, they may begin working on their project.
3. Final Project
   This project will summarize everything students have done in this course. Once students pick a topic, submit their project proposal and it gets approved, they can then begin to work on gathering data and organizing it. As students work on their project, they will fill out a Project Tracker. On this Project Tracker, they will record their progress, questions, and ideas. There will also be a daily journal at the beginning and end of class where they will record goals and questions. A rubric will be provided to give students an idea of what the final product should look like. Students will have time to work on this in class and at home. Once students have made revisions after their Peer Feedback, they will present their projects to the class. As they present, students will record on an index card one thing they learned and one question they have. The presenter will collect these and answer questions. The teacher will be grading the project off the created rubric.
4. Project Peer Feedback
   Before students submit and present their final project, they will be grouped up and presenting what they have as a rough draft. As they present, those who are listening will provide feedback, ask questions, and give tips. One all group members have presented; students will then break apart from their groups and begin to make final revisions before they submit and present to the entire class.
5. Weekly Check Ins
   This will be a combination of the journal entries students are making at the beginning and ending of every class and the Project Trackers they are filling out while working on their projects. There will be a certain amount of entries or check points students will need to enter by the end of every week. The goal is to help keep students on track for finishing the project in a timely manner.
6. Project Reflection
   Once all students have presented their final project, students will complete a final project reflection. In this reflection they will answer the following questions:
   - What did you learn about the data science process from completing this project?
   - What did you learn about your project topic that surprised you?
   - What was most challenging about this project?
7. Course Reflection
   As a class, have a conversation about what students thought about the class. Some questions discussed will include:
   - Which unit was the most compelling for you?
   - Which project are you most proud of? Why?
   - What did you learn about data science this year?
   - What was most challenging this year?
   - What was most interesting this year?
   - How will this change how you see the world?
   - What would you like to explore further?
   - What do you want to learn next?

Resources:
YouCubed
YouTube Videos
CODAP
Rubrics

Unit Modifications for Special Population Students	
Advanced Learners	Lead class discussions/Data Talks Lead groups in activities Provide feedback and tips for fellow students Present projects Ask meaningful questions for other students' projects Contribute to class conversations.
Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
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Integration of 21st Century Skills

Indicators:

From the Partnership for 21st Century Skills (P21), the deeper learning competencies and skills for 21st century learning in this unit include collaboration, creativity, and communication.

Unit Title: Programming in RStudio

Unit Description:
In this last unit, students will spend the remainder of the year coding/programming using RStudio and the R Language. RStudio is an integrated development environment (IDE) for writing and executing R code. R is a statistical programming language that allows us to write code to work with data and it is open source, meaning it is free and constantly updated. The good news is that students can take some of the skills they learned from coding in EduBlocks and Python earlier in the year and apply it to R (of course some of the syntax and structure will be different). Many Data Scientist use the R language to read, analyze and visualize data sets, so this Unit will be great for those who are considering going into the field.

Unit Duration: Approximately 4 weeks

Desired Results

Standard(s):
8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.

8.1.12.AP.2: Create generalized computational solutions using collections instead of repeatedly using simple variables.

8.1.12.AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.

Indicators:

Individuals evaluate and select algorithms based on performance, reusability, and ease of implementation.

Programmers choose data structures to manage program complexity based on functionality, storage, and performance trade-offs.

Complex programs are developed, tested, and analyzed by teams drawing on the members' diverse strengths using a variety of resources, libraries, and tools.

Understandings:
Students will understand that…

- RStudio is an integrated development environment (IDE) for writing and executing R code.
- R is a statistical programming language that allows us to write code to work with data and it is open source, meaning it is free and constantly updated.
- There are many free programs such as GitHub, Atom, Visual Code Studio, etc. to help us with coding in R.
- The Command Line is a text-based interface on a computer that allows us to communicate with the machine. As a data scientist, students will mainly use the command line to manage their files and keep track of code.
- It is important to produce well-structured and styled documentation to make it easier to share and present data. Another Data Scientist or programmer should be able to read and understand your data/code easily.

Essential Questions:

- What is RStudio? What is R code?
- What programs can be used to help students be successful with coding in R?
- What is the Command Line and how does it help us with coding?
- Why is it important to have well-structured code/data?
- How is the syntax of R similar to Python? How is it different?

Assessment Evidence

Performance Tasks:

Students will be able to…

- Install necessary programs to successfully code in R Language.
- Use the command line for basic file system navigation.
- Use git software to track line-by-line code changes.
- Use GitHub to help write code.
- Use Markdown to produce well-structured and styled documentation to make it easier to share and present data.
- Write their first programs using the R Language.

Other Evidence:

- Class discussions
- Independent Work
- Group Work
- Weekly Reflections
- Projects
- Data Talks

Benchmarks:

Command Line Assignment
Git and GitHub Activity
Writing Markdown Activity
RStudio Assignment

Learning Plan

Learning Activities:

1. Math Journal
   Most of the time, students will end class by answering several questions in their Math Journal. These questions will reflect on activities completed in class and be used to help build their portfolio.
2. Download Software
   Students will need to download and install several programs in order to successfully code in the R Language. These programs include RStudio, git, GitHub (create an account), Atom, and R Interpreter. All of these programs are free.
3. Command Line
   Students will start by learning how to open up the command shell on their windows laptops. When it opens up, it may be confusing at first, but the class will break down what each part of the text means. From there, students will learn about different command prompts such as pwd, cd, ls, mkdir, etc. These command prompts will help us navigate files, change directories, list files, and manage files. The command line is an essential tool for data scientist when working with large amounts of data and files.
4. Git and GitHub Activity
   One of the most important parts of writing code to work with data is being able to keep track of changes. Maintaining a clear and well documented history of work is important for collaboration. Students will be using the git command line program to track changes in code and GitHub to collaborate with other students. The main part of the activity will have students create a repository, add a file (text file of their favorite songs), and check the status of the file all using git. Students will then store their projects on GitHub where other students will have to download it and access it. Once downloaded, they should be able to check the history of the project, as well as revert it to earlier versions.
5. Writing Markdown Activity
   Students will learn that they need to format plain text without the use of Microsoft word. To do this, students will discuss the basics of Markdown syntax. Markdown is a lightweight syntax used to

describe the format and structure of text documents. Students will be given text and use Markdown to format it (bold, italics), create text blocks, add hyperlinks, and insert images and tables. Once students are done, they will render their Markdown and submit a copy to the teacher.

6. RStudio Assignment
   Students will finally be introduced to the R Language via RStudio. Students will start by opening RStudio and discussing the various parts and buttons they see on their screen. As a class, students will write a program for the number of cups of coffee and tea they have had. While writing the code, students will be introduced to defining variables in their program as well as inserting comments to help organize. By the end, their program in RStudio should take in the number of cups of coffee and tea they have had and print out a caffeine level. This is meant to be an easy program for students to write to help build their interest into learning more.

Resources:
RStudio
GitHub
Atom
R Language
Programming Skills for Data Science: Start Writing Code to Wrangle, Analyze, and Visualize Data with R textbook by Michael Freeman and Joel Ross

Unit Modifications for Special Population Students	
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Struggling Learners	Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g., multiple representation and multimodal experiences). Structure lessons around questions that are authentic, relate to students' interests, social/family background, and knowledge of their community.
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