Board of Education

5 Minortown Road ~ Woodbury, CT 06798
www.ctreg14.org

Mission: The mission of Connecticut Region 14 Schools is to educate all students to their highest level of academic potential and to teach them the skills and knowledge to become capable, creative, collaborative lifelong learners and responsible members of the world community.

Board of Education Goals:
Academic Performance - The district will strive to improve academic performance for all students on multiple assessment indicators and the staff will be committed to continuous improvement.
Communication - Region 14 will develop partnerships with all stakeholders in the school community to highlight the exemplary programs the district offers
Safety - Region 14 will provide safe and secure facilities equipped with technology, enabling a 21st century learning environment that supports the values of the district
Budget - Region 14 will prepare a budget that meets the needs of every student and communicates the needs and priorities of Region 14 in a clear and concise manner.

A G E N D A

Regular Meeting of the Region 14 Board of Education
Monday, December 2, 2024; 6:00 p.m.
Mitchell Elementary School
Flanders Room

I. Call to Order……...…..James Crocker

II. Pledge of Allegiance……....James Crocker

III. Introductions…….…….……James Crocker

IV. Approval of Minutes (Action Anticipated)…….James Crocker
N/A

V. Superintendent's Report
   A. Board of Education Student Representative Report
   B. Nonnewaug High School National Merit Semi-Finalists
   C. Middle School Music Department Grant
   D. Woodbury Middle School Development Plan
   E. Nonnewaug High School Development Plan

VI. Committee Reports

A. Curriculum Committee

1. On a recommendation by the Curriculum Committee to accept/approve the following curricula: (Action Anticipated)
    a. Calculus Honors
    b. AP Computer Science Principles
    c. Computer Programming with Mathematical Modeling
    d. Algebra II
    e. Probability and Statistics
    f. Computer Aided Drafting

B. Finance Committee

1. RFP Bus Transportation (Action Anticipated)

C. Policy Committee

1. On a recommendation by the Policy Committee to accept/approve the following policies: (Second Read, Action Anticipated)
    a. Policy 0200 District Goals
    b. Policy 0521 Nondiscrimination Policy and Notice

VII. Board Chair's Comments

VIII. Privilege of the floor

The Board of Education will recognize citizens of Bethlehem and Woodbury, any parent/guardian of a child enrolled in the Region 14 School District, or any current employee of the Region 14 School District who are asked to state their name and town of residence and to please limit comments to three (3) minutes. Up to 21 minutes of statements per topic are allowed. All comments should be addressed to the Board of Education Chair. Decorum will be enforced.

IX. Old Business

X. New Business

A. 2025 Board of Education Meeting Dates (Action Anticipated)

B. Discussion and possible action on ratification of proposed collective bargaining agreement between the Region 14 Board of Education and the Nonnewaug Teachers' Association dated July 1, 2025 – June 30, 2028 (Executive Session Anticipated)

XI. Other Business

XII. Adjournment

CALCULUS HONORS CURRICULUM

Grade Level(s): 12

Curriculum Author(s): Raymond Robillard

Course Description: Calculus is a full-year course designed to provide students with a basic understanding of Differential and Integral Calculus as it applies to business, finance, the social sciences, environmental sciences, physical sciences, etc. Students will engage in the study of Calculus through real-world application and prepare for the post-secondary study of Calculus.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Limits	How can limits help understand the behavior of functions?	A limit describes the function value approached as the independent variable infinitely approaches some value or infinity.	TCC1(9-12); AA1(9-12)
Derivatives	What is a derivative?	The derivative is more than the slope of the tangent line. It represents an instantaneous rate of change for modeled quantities relative to some other variable, often time.	TCC3(9-12); AA2(9-12):
More Derivatives	Are there types of functions for which we cannot find a derivative?	There are differentiation shortcuts for all families of functions learned in high school math.	TI3(9-12); AA1(9-12)
Applications of Derivatives	What real world problems can be solved using differentiation?	Functions allow us to optimize processes across a vast array of fields and careers.	TCC1(9-12); TI1(9-12)
Integration	What does the integral represent in a real world situation?	An integral allows us to calculate the total change in any measurable variable for any real world application.	TI3(9-12); AA2(9-12)
Slope Fields, Euler's Method, U-Substitution, and L'Hopital's Rule	How can we analyze the behavior of a function (sometimes without knowing what it is)?	Advanced Calculus techniques can be used to analyze differential equations, integrate composite functions, and determine limits of indeterminate forms.	TI1(9-12); TI3(9-12)
Geometry of Calculus	How can we use Calculus to measure the size of things in the real world?	Calculus allows us to measure the length, area, and volume of infinitely complex shapes.	TCC1(9-12), TI1(9-12)
***Units in this document do not appear to match numbers indicated on assignments. This is because the first chapter of our textbook is a precalculus review unit that is not taught in this course. For example, the first assignment in Unit 1 is labeled number 2.1 because it corresponds to the first section of chapter 2 in our textbook.**			

Unit 1 - Limits

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSN.Q.A.3-Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
HSA.SSE.B.3-Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
HSF.IF.C.7-Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...

- A limit describes the function value approached as the independent variable infinitely approaches some value or infinity.
- A two-sided limit exists if and only if the one-sided limits exist and are equal.
- A function is continuous at a point if and only if the two sided limit exists at the point and is equivalent to the function value at that point.
- A function is continuous if and only if it is continuous at every

Essential Questions:

- How can limits help understand the behavior of functions?
- How can limits be used to define continuity of a function?
- How can we calculate slope at a single point on a function?

point. • A limit can be used to find an instantaneous rate of change(slope of a tangent line)	
Students will know… • The definition of a limit • Proper notation of a limit • Concept of limit can be extended to include one-sided limits • A limit may not exist for some functions at a particular x value • End behavior of a graph can be described using limits • Definition of continuity • Different types of discontinuity • The slope between two points is an average rate of change • The slope at one point is an instantaneous rate of change	**Students will be able to...** • Find limits numerically • Find limits graphically • Find limits algebraically • Use a limit at infinity to describe end behavior • Determine continuity at a point • Classify types of discontinuities • Find the slope of a tangent line at a point
Key Vocabulary: Limit; One-sided limit; Two-sided limit; End Behavior; Continuous/Discontinuous; Removable discontinuity; Infinite discontinuity; Jump discontinuity; Average rate of change; Instantaneous rate of change	
Assessment Evidence	
Performance Tasks: **Summative Unit Assessment** TCC1(9-12) and AA1(9-12) Topics will include: • Evaluating limits at a constant • Evaluating limits at infinity • Evaluating limits with a graph/table • Identifying and describing types of discontinuities • Calculate and average rate of change • Finding equations of lines tangent to a function at a point	**Other Evidence:** Book Practice (Classwork and Homework Assignments): • 2.1- P. 65-67 #3,7,9,11,13,25,27,29 • 2.1- P. 65-67 #43,44,45,47,49 • 2.2- P. 76-77 #1,5,13,15,19,21,22,23,27,35-38 • 2.3- P. 84-85 #1,2,4,5,7,23,25,48 • 2.4- P. 93-95 #1,9,23,26 Interim: • Quiz on Evaluating Limits
Learning Plan	
In this unit, students will be introduced to the concept of the limit. Students will evaluate limits with the informal understanding of “getting as close to a point as possible without actually getting there”. The idea of calculating a slope between two points has become second nature to students since Algebra 1, so the concept of finding a slope of a tangent line from a single point will seem impossible before seeing how a limit allows us to solve such a problem. • 2.1- Students will evaluate limits at a point using substitution in cases where a function is continuous at that point. They will also use	

algebraic techniques to remove discontinuities. Students will evaluate limits graphically, extending their knowledge to one and two-sided limits. **AA1(9-12)**

- 2.2- Students will evaluate limits at infinity and limits that produce infinite discontinuities. End behavior and asymptotes will be reinforced.**TCC1(9-12)**
- 2.3- Students will define continuity, both at a point, and across an entire function.**TCC1(9-12)**
- 2.4- Students will calculate the average rate of change using the slope formula and generalize the formula to find the slope of a tangent line at a single point. **TCC1(9-12)**

Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

Unit 2 - Derivatives

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSN.RN.A.1-Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.
HSN.RN.A.2-Rewrite expressions involving radicals and rational exponents using the properties of exponents.
HSA.SSE.A.2-Use the structure of an expression to identify ways to rewrite it.
HSA.SSE.B.3-Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
HSF.IF.B.6-Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
- AA2(9-12): I can assess my past successes and mistakes to change my approach.

Understandings: Students will understand that...

- The derivative is more than the slope of the tangent line. It represents an instantaneous rate of change for modeled quantities relative to some other variable, often time.

Essential Questions:

- What is a derivative?
- What happens to the slope between two points as they come infinitely close to one another?

• There are many techniques to determine derivative functions, and in some cases, multiple ways to reach these solutions. • The derivative of a function is also a function (and thus has a corresponding graph).	
Students will know… • Proper derivative notation. • The first derivative is velocity of a distance function • A function is non-differentiable at a cusp, corner, vertical tangent line, or a discontinuity. • The general forms of the power rule, product rule, and quotient rule. • The derivatives of the 6 basic trigonometric functions.	**Students will be able to...** • Evaluate the derivative by taking the limit of the difference quotient • Calculate the derivative using differentiation rules (including trigonometric functions) • Write the equation of the tangent line to a specific point on a curve • Solve rate of change application problems using the derivative • Determine velocity of a moving object
Key Vocabulary: Limit definition of the derivative; Instantaneous rate of change; Position/Velocity; Cusp; Corner; Vertical Tangent Line; Discontinuity; Power Rule; Product Rule; Quotient Rule	
Assessment Evidence	
Performance Tasks: **Summative Unit Assessment** TCC3(9-12) and AA2(9-12) Topics will include: • Defining a derivative using the limit definition • Determining the value of a derivative at a point, or across a whole function, using the limit definition of the derivative • Explain the four types of ways a function can fail to be differentiable • Sketch graphs of derivatives of functions • Use the shortcuts of differentiation to determine f'(x) given f(x)	**Other Evidence:** Book Practice (Classwork and Homework Assignments): • 3.1- P. 107-108 #1-3, 13-16 • 3.2- P. 116-117 #3,8,10,12,15 • 3.3- P. 126 #1,2,5,6,9,15,16,17,19,20,29,31,33 • 3.5- P. 147-148 #1,2,4,8,11,13,21,23 Interim: • Quiz on Differentiability • Product and Quotient Rule Matching Game Activity
Learning Plan	
In this unit, students will formalize their evaluation of a slope of a tangent line from a point to the concept of the derivative. They will start to discuss what, exactly, a derivative is and see applications for its use. They will learn shortcuts for differentiation and discover ways that differentiation doesn't hold for a function f'(x). This knowledge will extend to trigonometric functions.	

- 3.1- Students will use the limit definition of the derivative to evaluate a derivative value at a point.**AA2(9-12)**
- 3.2- Explore and classify ways the a function could fail to be differentiable at a point.**AA2(9-12)**
- 3.3- Find derivatives, f'(x), of functions, f(x), using shortcuts of differentiation including the power rule, product rule, multiplication rule, and by rewriting radicals and rational functions as powers with negative or fractional exponents.They will also begin to sketch graphs of derivatives. **TCC3(9-12)**
- 3.5- Students will determine derivatives of basic trigonometric functions.**TCC3(9-12)**

Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

Unit 3 - More Derivatives

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSN.Q.A.2-Define appropriate quantities for the purpose of descriptive modeling.
HSA.SSE.A.2-Use the structure of an expression to identify ways to rewrite it.
HSA.SSE.B.3-Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
HSA.CED.A.2-Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
HSF.IF.B.4-For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
HSF.BF.B.5-Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
HSF.IF.B.6-Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
HSF.IF.C.7-Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
HSF.BF.A.1-Write a function that describes a relationship between two quantities.*
HSF.BF.B.5-Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
HSF.LE.A.3-Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI3(9-12): I can formulate and investigate probing questions to further my learning.
- AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...

- When differentiating a composite function, one cannot simply differentiate only the inner and outer function.
- Implicit differentiation is necessary for differentiating a relation in terms of multiple variables
- There are differentiation shortcuts for all families of functions learned in high school math.

Essential Questions:

- Are there types of functions for which we cannot find a derivative?
- Can we find the derivatives of relations that are not functions
- How are the derivatives of functions and the derivatives of their inverses related?

Students will know...

- Given a function f(x) = g(h(x)), then f'(x) = g'(h(x))*h'(x).
- The derivative of a relation of multiple variables will require the use of the chain rule.
- The derivative of f(x) = a^x is f'(x) = (log a) a^x. e^x is a special case.
- The derivative of $f(x) = \log_a x$ is f'(x) = 1/ (x(ln a)). ln x is a special case.
- Given f(x), the derivative of $f^{-1}(x)$ is $(f^{-1})'(x) = 1/ f'(f^{-1}(x))$. ln x is a special case.

Students will be able to...

- Find a derivative of a composite function
- Find a derivative of a relation in multiple variables
- Find a derivative of an exponential function
- Find a derivative of a logarithmic function
- Find a derivative of an inverse function for f(x)

Key Vocabulary: Chain Rule; Newton's Notation/Leibniz's Notation; Implicit Differentiation; Euler's Number; Exponential Function; Logarithmic Function; Inverse Function

Assessment Evidence

Performance Tasks:
Summative Unit Assessment TI3(9-12) and AA1(9-12)
Topics will include:

- Differentiating functions using the chain rule
- Differentiating relations using implicit differentiation
- Differentiating exponential and logarithmic functions
- Finding a general derivative of an inverse function

Other Evidence:
Book Practice (Classwork and Homework Assignments):

- 4.1- P. 160-161 #1,5,6,13,15,16,29,33
- 4.2- P. 170 #1-4,9-13,15-22,27-40
- 4.4- P. 186 #1-35(Odds)

Interim:

- Quiz on Chain Rule
- Implicit Differentiation "Around the Room" Activity
- Quiz on Implicit Differentiation and Logarithmic/Exponential Derivatives

Learning Plan
In this unit, students will expand on their knowledge of derivatives and differentiation techniques. They will be able to differentiate composite functions, relations in multiple variables, and exponential and logarithmic functions. These topics, seemingly unrelated, build closely on each other, leading students to an understanding of how differentiation techniques, in general, came to be developed. ● 4.1- Students will discover and utilize the Chain Rule, a technique for differentiating composite functions. Students will be given the real world example of unwrapping a present to emphasize the "removal of the outer layer, while keeping the inner contents unchanged, before moving onto the inner layer".**AA1(9-12)** ● 4.2- The chain rule, represented with Leibniz's notation, will serve as the basis for differentiating relations in multiple variables. Students will see the chain rule as a way to differentiate a relation in terms of a variable other than the one the derivative is being taken in terms of.**AA1(9-12)** ● 4.3- Students will be shown the technique for differentiating an exponential function. Then, the chain rule, and an understanding of inverse functions, allows students to build upon this knowledge to find the derivatives of logarithmic functions. The process can be generalized to find the derivative of any inverse function, such as inverse trigonometric functions.**TI3(9-12)**
Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

Unit 4 - Applications of Derivatives

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSN.Q.A.1-Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.
HSN.Q.A.2-Define appropriate quantities for the purpose of descriptive modeling.
HSA.SSE.A.1-Interpret expressions that represent a quantity in terms of its context.
HSA.CED.A.2-Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
HSA.CED.A.3-Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
HSA.CED.A.4-Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
HSF.BF.A.1-Write a function that describes a relationship between two quantities.
HSG.MG.A.3-Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.

Understandings: Students will understand that…	**Essential Questions:**
● Functions allow us to optimize processes across a vast array of	● What real world problems can be solved using differentiation?

fields and careers. ● A function can only have, at most, one absolute maximum and one absolute minimum, although these can occur in multiple places. ● An inflection point is where the concavity of a function changes. ● A related rates problem involves 2 or more derivatives. ● Proper notation is critical for communicating clear mathematics.	● How does the instantaneous rate of change over a function relate to the average value of a function? ● What do the derivative and the second derivative tell us about a function?
Students will know... ● Endpoints and critical numbers must be evaluated when seeking absolute extrema ● A function must be continuous on some interval [a,b] and differentiable on (a,b) for the Mean Value Theorem to be applied. ● The values of f''(x) tell us about the concavity of f(x) ● An optimization problem with a real world context frequently involves extraneous answers. ● There is a significant difference between d/dx and dy/dx.	**Students will be able to...** ● Find the absolute and relative extrema of a function, either over an interval, or including end behavior. ● Justify the validity of the Mean Value Theorem. ● Sketch a graph of f''(x) given a function f(x). ● Solve an optimization problem. ● Solve a related rates problem.
Key Vocabulary: Extrema; Local(relative) Maximum/Minimum; Global(absolute) Maximum/Minimum; Hypothesis; Conclusion; Mean Value Theorem; Acceleration; Concavity; Inflection Points; Optimization; Related Rates	
Assessment Evidence	
Performance Tasks: **Summative Unit Assessment TCC1(9-12) and TI1(9-12)** Topics will include: ● Determining extrema from a function. ● Determining extrema from a graph. ● Explaining what we know of a situation based on the Mean Value Theorem. ● Matching the graphs of f, f', and f'' and providing rationale for why graphs connected with each other. ● Solving optimization problems in context ● Solving related rates problems in context	**Other Evidence:** Book Practice (Classwork and Homework Assignments): ● 5.1- P. 200 #1,3,5,7,9,11,15,19,23,29,35,37 ● 5.2- P. 208 #1,4,6,11,12 ● 5.3- P. 220 #7,9,12,13,16,20 ● 5.3- P. 220 #21,22,23,24,25,29 ● 5.3- P. 220 #31,33,35,37 ● 5.4- P. 231 #1,7,9,17,23 ● 5.6- P. 257 #1,3,11,13,17,31 Interim: ● Matching game for graphs of f, f', and f'' ● Quiz on extrema, Mean Value Theorem, and graphs of f, f', and

	f” ● Quiz on optimization and related rates

Learning Plan

In this unit, students will utilize all they have learned so far about differentiation to solve a variety of real world problems. The Mean Value Theorem, connecting position, velocity, and acceleration, optimization, and related rates are concepts that professionals in all fields use to make informed decisions. An understanding of extrema sets up optimization and so it starts out this unit.

- 5.1- Students will use the first derivative of a function to determine the local(relative) and global(absolute) extrema of a function. They will do this both algebraically and graphically and compare and contrast the results.**TCC1(9-12)**
- 5.2- Students will learn and utilize the Mean Value Theorem to make claims and validate statements about the instantaneous rate of change of a function based on the average rate of change of the function. The real world example of speeding on the Massachusetts Pike will serve as the backbone for students grasping this concept.**TCC1(9-12)**
- 5.3- Up to this point, students have studied the connections between the graph of a function f(x) and its derivative f’(x). Ideally, by this point, a student has inquired about the graph of the derivative of f’(x), or f’’(x) and how this might provide us information about the original function f(x). Position, velocity, and acceleration graphs are used here to demonstrate these connections. Students learn about concavity and inflection points. **TCC1(9-12)**
- 5.4- In the third of four application driven sections in this unit, students will build upon the techniques learned in section 5.1 and solve real world optimization problems. Topics will include optimizing profit, minimizing materials needed to make containers, maximizing area for a fixed perimeter, and more.**TI1(9-12)**
- 5.5- In this section,students will build upon their knowledge of implicit differentiation from section 4.2 to solve problems involving related rates. Such topics include, the rate at which a snowball melts, how the viewing angle changes as a plane flies overhead, and how full a bathtub is as it drains. A point of emphasis that helps students here is to clarify the difference between the notation of d/dx and dy/dx.**TI1(9-12)**

Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

Unit 5 - Integration

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSA.SSE.A.2-Use the structure of an expression to identify ways to rewrite it.
HSA.SSE.B.3-Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TI3(9-12): I can formulate and investigate probing questions to further my learning.
- AA2(9-12): I can assess my past successes and mistakes to change my approach.

Understandings: Students will understand that...

- An integral allows us to calculate the total change in any measurable variable for any real world application.
- An area under a curve can be approximated by an infinitely large number of infinitely thin rectangles.
- The antiderivative of a function f is a function g whose derivative is f.
- A definite integral represents an area under a curve. (FToC part 1)
- The accumulation of area under a curve up to some variable point produces an accumulation function related to the

Essential Questions:

- Why is it necessary to have an inverse process to differentiation?
- What does the integral represent in a real world situation?

antiderivative of the integrand. (FToC part 2)	
Students will know... ● How to determine the width of a rectangle when finding a Riemann Sum. ● An antiderivative produces a family of functions and thus requires a constant of integration ● Proper notation of integration. ● Both parts of the FToC.	**Students will be able to...** ● Approximate an area under a curve with a Riemann Sum. ● Find an exact area under a curve using Geometry. ● Find a general and specific antiderivative of a function. ● Evaluate a definite integral. ● Apply the FToC part 2 to produce a new function (the accumulation function)
Key Vocabulary: Riemann Sum; RRAM (Right Rectangle Approximation Method); LRAM (Left Rectangle Approximation Method); Antiderivative; Constant of Integration; Integral; Integrand; Limits of Integration; Definite Integral; Indefinite Integral; Fundamental Theorem of Calculus; Accumulation function	
Assessment Evidence	
Performance Tasks: **Summative Unit Assessment TI3(9-12) and AA2(9-12)** Topics will include: ● Approximating the area under the curve with a Riemann Sum. ● Find the exact area under the curve of a function using formulas from Geometry. ● Finding antiderivatives, F(x), from a function, f(x). ● Evaluating a definite integral using the FToC part 2. ● Producing a function for an interval with variable limit of integration using the FToC part 1.	**Other Evidence:** Book Practice (Classwork and Homework Assignments): ● 6.1- P. 277 #7,8,19 ● 6.2- P. 291 #7-25(Odds) ● 6.3- P. 304 #3-33(Odds) ● 6.4- P. 310 #1-19(Odds) ● 6.4- P. 311 #27-39(Odds) Interim: ● Basic Integration Quiz ● Quiz on area under the curve, definite integrals, and the Fundamental Theorem of Calculus
Learning Plan	
In this unit, students will be introduced to the integral, a formalization of an area under the curve using an antiderivative. This unit is a pivotal bridge between Differential and Integral Calculus and is typically when students begin to make strong connections between all the key components of Calculus. Care should be taken in this section when working with students on antiderivatives, especially those with rational or negative exponents, as they tend to be quite error prone(the students, not the exponents!). ● 6.1- In this section, students are introduced to the concept of the Riemann Sum. The concept of finding the area of a rectangle is elementary to them, but the concept of doing so with an infinitely increasing number of increasingly thin rectangles reinforces that Calculus	

is a study of extremes. This section begins with an activity relating to estimating the area of the main island of Hawaii.

- 6.2- Students diverge from using rectangles to approximate an area to studying the area under a curve using a variety of geometric shapes. This section often is taught with a review sheet of area formulas from Geometry.
- 6.3- The antiderivative is introduced in this section. Students have experience with the concept of an antiderivative, naturally working in reverse of the differentiation process they have mastered over the course of semester 1. What is different is the introduction of the constant of integration, C, that shows the solution to an antiderivative problem is not just a single function, but, in fact, an entire family of functions.
- 6.4- Combining the aspects of sections 6.1, 6.2, and 6.3, students arrive at the most important theorem in Calculus: the Fundamental Theorem of Calculus. Starting with the new notation for an integral, and given in two parts, the first part demonstrates the connection between an integral and area under the curve whereas the second part provides an algebraic technique for using the antiderivative to calculate the value of a definite integral.

TI3(9-12) and AA2(9-12) - Summative Unit Assessment

Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

Unit 6 - Slope Fields, Euler's Method, U-Substitution, and L'Hopital's Rule

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSA.SSE.A.2-Use the structure of an expression to identify ways to rewrite it.
HSA.SSE.B.3-Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
HSF.IF.C.7-Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
- TI3(9-12): I can formulate and investigate probing questions to further my learning.

Understandings: Students will understand that...

- Advanced Calculus techniques can be used to analyze differential equations, integrate composite functions, and determine limits of indeterminate forms.
- Slope Fields are a graphical representation of a family of antiderivatives. Euler's Method "traces out" these particular antiderivatives using small line segments of a chosen size.
- A good choice for the expression of u, when using u-substitution, is one whose derivative is also part of the

Essential Questions:

- How can we analyze the behavior of a function (sometimes without knowing what it is)?
- Does the chain rule have a corresponding integration technique?
- Are there different sizes of infinity?

integrand, give or take a constant multiple. ● Indeterminate Forms can yield different limit values depending on the structure of the form.	
Students will know... ● Slope Fields are more accurate as we graph more “slope pieces” ● Euler’s Method is the basis for modern day GPS navigation. ● U-substitution is ideal when an integrand includes an expression AND a form of its derivative. ● L’Hopital’s Rule focuses on the rate at which expressions approach 0 or infinity.	**Students will be able to...** ● Match slope fields to differential equations. ● Estimate a function value with Euler’s Method. ● Use u-substitution to find an antiderivative. ● Evaluate a limit that produces an indeterminate form
Key Vocabulary: Slope Field; Differential Equation; Euler’s Method; U-Substitution; Indeterminate Form; L’Hopital’s Rule; Cardinalities of Infinity	
Assessment Evidence	
Performance Tasks: **Summative Unit Assessment TI1(9-12) and TI3(9-12)** Topics will include: ● Matching slope fields with corresponding differential equations ● Estimating a function value using Euler’s Method ● Evaluating indefinite integrals using u-substitution ● Evaluating limits using L’Hopital’s Rule	**Other Evidence:** Book Practice (Classwork and Homework Assignments): ● 7.1- P. 335 #29-46,51,57 ● 7.2- P. 343 #17,20,21,22,32,39,56,60 ● 9.2- P. 458 #17,23,33,39,49,51,65 Interim: ● Quiz on slope fields and Euler’s Method ● Quiz on U-Substitution and L’Hopital’s Rule
Learning Plan	
This unit is a bit of a hodgepodge of topics that bridge this course and Calculus 2 or Calculus 3 courses that students may take in college. Slope FIelds and Euler’s Method are an introduction to the concept of differential equations, a core topic of Calculus 3. U-Substitution and L’Hopital’s Rule extend the concepts of integration and limits to more complex tasks. These topics are included due to their accessibility as extensions of concepts learned in this class. ● 7.1- Slope fields and Euler’s Method allow students to investigate concepts relating to differential equations. The family of functions produced by a slope field demonstrates, graphically, the need for a constant of integration. Students look for key features of a slope field to match it to its corresponding differential equation. Euler’s Method provides a way of estimating function values in the absence of an expression for the function, assuming we know its derivative.**TI3(9-12)** ● 7.2- Students have previously learned how to differentiate a composite function using the chain rule. Here they learn how to	

antidifferentiate to a composite function. A real world metaphor of a shopping cart carrying watermelons helps students see the components and purpose of the process as it focuses on the "container" (the expression set equal to u) that allows the process to be simplified before antidifferentiation and "unpacked" afterwards.**TI1(9-12)**

- 9.2- L'Hopital's Rule provides a method for evaluating limits that result in indeterminate forms such as 0/0 or infinity/infinity. Students discover that, equally important as the values an expression approaches, is the rate at which it approaches these values.**TI3(9-12)**

TI1(9-12) and TI3(9-12) - Summative Unit Assessment

Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

Unit 7 - Geometry of Calculus

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards
HSA.SSE.A.1-Interpret expressions that represent a quantity in terms of its context.
HSN.Q.A.2-Define appropriate quantities for the purpose of descriptive modeling.
HSG.GMD.A.3-Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
HSG.GMD.B.4-Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
HSG.MG.A.1-Use geometric shapes, their measures, and their properties to describe objects

Standards for Mathematical Practice
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP6: Attend to precision.
MP7: Look for and make use of structure.
MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.

Understandings: Students will understand that…	**Essential Questions:**
• Calculus allows us to measure the length, area, and volume of infinitely complex shapes. • Area is the summation of an infinite number of lengths and volume is the summation of an infinite number of areas. • The processes of finding area, volume, and length can be done relative to either the x or y axis.	• How can we use Calculus to measure the size of things in the real world? • How are the concepts of length, area, and volume related?
Students will know... • The area between two curves can always be written as the absolute value of the area under one curve minus the area of the other. • All 3 dimensional solids can be reduced to an infinite number of 2 dimensional cross sections. • Arc length techniques allow us to measure a curved distance.	**Students will be able to...** • Find the area between two curves relative to either the x or y axis. • Find the volume formed by a function rotated around some axis of revolution using the disc method. • Find the length of a curve relative to either the x or y axis.

Key Vocabulary: Area between curves; Disc method; Axis of rotation; Arc length

Assessment Evidence

Performance Tasks:	**Other Evidence:**
Summative Unit Assessment TCC1(9-12) and TI1(9-12) Topics will include: • Setting up and solving an integral to find the area between two curves • Setting up and solving an integral to find the volume of a solid of revolution using the disc method • Setting up and solving an integral to find the length of a curve relative to either the x or y axis	Book Practice (Classwork and Homework Assignments): • 8.2- P. 402 #1,5,6,9,13,15,17 • 8.3- P. 415 #7,10,11,14,15,17,18 • 8.4- P. 424 #1,4,9,11,15

Learning Plan

This unit is a synthesis of concepts from Geometry, through the lens of Calculus. Each of these processes takes a geometric technique and utilizes it on an infinitely small scale with a summation that produces a valid solution. What appeals most to students is when they can prove the

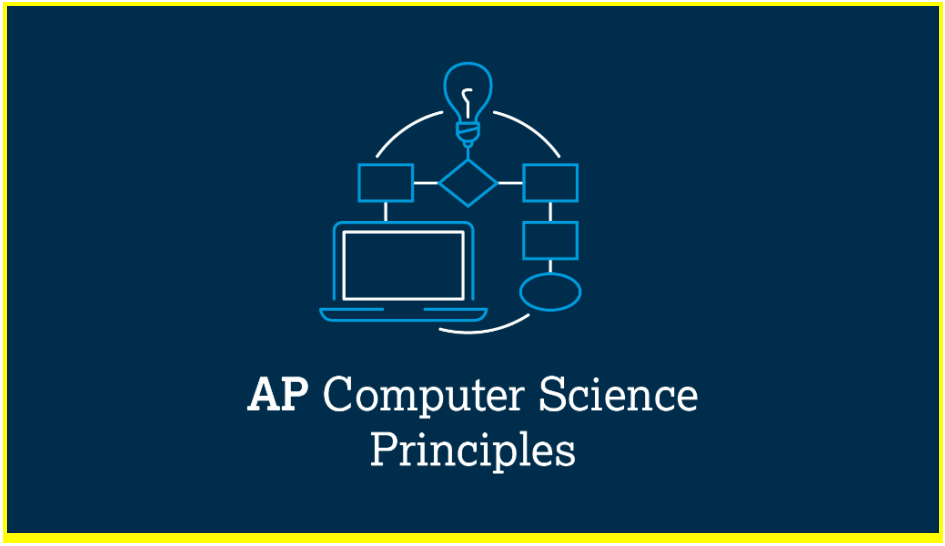
seemingly random formulas and techniques of days past through the power of integration.

- 8.2- Students will first solve problems involving integrals to find the area between two curves in a way similar to Geometry problems like the infamous “circle cut of a square” problem. **TI1(9-12)**
- 8.3- Volume formulas in Geometry were memorized, but here students create integrals that can find the volume of even the most irregular solids by considering them as an infinite number of infinitely thin discs. **TCC1(9-12)**
- 8.4- Finally, students utilize the distance formula, learned a few years ago, as part of an integral that sums an infinite number of infinitely small segments to determine arc length. **TCC1(9-12)**

TCC1(9-12) and TI1(9-12) - Summative Unit Assessment

Teacher Resources: Textbook: Calculus: Graphical, Numerical, Algebraic; TI Smartview Software and individual calculators; Teacher created in-class notes, activities, and problem sets

AP COMPUTER SCIENCE PRINCIPLES CURRICULUM



Grade Level(s):10-12

Curriculum Author(s): Raymond Robillard

Course Description: The AP Computer Science Principles course opens up the world of Computer Science to all students by providing a CS course with a greater focus on fundamental concepts in CS without getting bogged down in the exact details of syntax for a specific programming language. This course covers both universal concepts in programming but also focuses on concepts such as: digital copyright issues, closing the technology gap created by economic inequity, how the internet functions, ethical issues in CS, data abstraction, and algorithms. The course has a heavy emphasis on collaboration. The AP Computer Science Principles course curriculum is compatible with many CS1 courses in colleges and universities. Students will be able to obtain college credits by successfully meeting a benchmark score on the Advanced Placement Exam. Block coding is utilized in the course through the online platform at code.org.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Digital Information	How can we use 1s and 0s to represent something complex like a video of the marching band playing a song?	The way a computer represents data internally is different from the way the data are interpreted and displayed for the user. Programs are used to translate data into a representation more easily understood by people.	TI3(9-12): I can formulate and investigate probing questions to further my learning. AA1(9-12): I can evaluate different approaches and justify the best pathway to success.
The Internet	What is the internet and how does it work?	The internet is a connected network of computing devices that uses an agreed upon series of protocols for the transfer of information.	TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. TI3(9-12): I can formulate and investigate probing questions to further my learning.
Intro to App Design	How does the interactive design of programs and apps impact its user base?	Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.	CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success. CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

Variables, Conditionals, and Functions	In what ways can we reduce code complexity through the use of conditional statements and functions?	Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.	TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals. AA1(9-12): I can evaluate different approaches and justify the best pathway to success.
Data	When is it more appropriate to use a computer to analyze data than to complete the analysis by hand?	We live in an era where data is so plentiful as to seem overwhelming and it has become increasingly important to know how to process and interpret it correctly.	TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
Lists, Loops, and Traversals	What types of abstractions are available to programmers and how are they used?	To find specific solutions to generalizable problems, programmers represent and organize data in multiple ways.	TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals. AA1(9-12): I can evaluate different approaches and justify the best pathway to success.
Parameters, Return, and Libraries	How do programmers utilize the work on one another to improve software?	Procedures allow programmers to draw upon existing code that has already been tested, allowing them to write programs more quickly and with more confidence.	TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals. AA1(9-12): I can evaluate different approaches and justify the best pathway to success.
Cybersecurity and Global Impacts	Are innovators responsible for the harmful effects of their computing innovations, even if those effects were unintentional? Why or why not?	While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.	TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.

			CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.
Algorithms	What common real-world problems can be solved with computer processed algorithms?	There exist real-world problems that computers cannot solve, and even when a computer can solve a problem, it may not be able to do so in a reasonable amount of time.	TCC3(9-12): I can integrate relevant information to produce multiple valid solutions. AA1(9-12): I can evaluate different approaches and justify the best pathway to success. AA2(9-12): I can assess my past successes and mistakes to change my approach.

Unit 1 - Digital Information

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3B-IC-27 - Predict how computational innovations that have revolutionized aspects of our culture might evolve.
3A-AP-21 - Evaluate and refine computational artifacts to make them more usable and accessible.
2-DA-07 - Represent data using multiple encoding schemes.
3A-DA-09 - Translate between different bit representations of real-world phenomena, such as characters, numbers, and images.
3A-CS-02 - Compare levels of abstraction and interactions between application software, system software and hardware layers.
3A-DA-10 - Evaluate the tradeoffs in how data elements are organized and where data is stored.
3A-IC-28 - Explain the beneficial and harmful effects that intellectual property laws can have on innovation.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
TI3(9-12): I can formulate and investigate probing questions to further my learning.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...

- The way a computer represents data internally is different from the way the data are interpreted and displayed for the user. Programs are used to translate data into a representation more easily understood by people.
- Programs can be used to process data, which allows users to discover information and create new knowledge.

Essential Questions:

- How can we use 1s and 0s to represent something complex like a video of the marching band playing a song?
- What types of problems can be solved more easily with a computer, and what types can be solved more easily without a computer? Why?

Students will know...

- Computing innovations change the way people interact and share information.
- All data can be reduced to binary representations.
- Binary representations of decimal numbers follow a pattern based on place value.
- Decimal numbers can be represented in binary with some limitations.
- 8 bits = 1 byte
- Text can be abstracted first as a number assigned to each character, and then to a binary representation.

Students will be able to...

- Communicate with classmates about computing innovations in their lives.
- Describe positive and negative effects of computing innovations.
- Explain how the same piece of information can be represented in a variety of different ways.
- Use a device to represent different pieces of information
- Use patterns to represent information
- Explain the challenges of creating a clear set of rules for ordering patterns
- Follow a set of rules for ordering sets of patterns

• Pixels in a monochrome image are represented by a bit, but colors require many more bits of memory per pixel. • The greater the sampling size, the more detailed an image will be. • Lossless compression means that data can be compressed and reassembled with perfect accuracy. • Lossy compression means that data loses some detail as part of the compression process. • Intellectual property laws, including copyrights, are governed by rules and expectations that face unique issues in a digital era. • Create Commons Copyrights allow creators to choose the ways in which their work can be shared.	• Explain how the position of each binary digit determines its place value and numeric value • Represent binary numbers using combinations of decimal (base 10) digits 0-9 • Represent decimal numbers using combinations of binary (base 2) digits 0 and 1 • Understand that overflow and roundoff errors result from real-world limitations in representing place value. • Describe the challenges in representing text when using a fixed number of bits for each character • Develop a system for using numbers to represent text • Explain how bits are grouped to represent abstractions like numbers and text. • Explain how bits can be used to represent the individual pixels of a black and white image • Explain how sampling is used to create a digital form of an analog image • Explain how bits can be used to represent the individual pixels of a color image • Explain how digital data is used to approximate real-world analog data • Analyze patterns in data to determine compression strategies • Create lossless compressions of text files • Examine the effects of lossy compression on text & images • Given a piece of media, decide whether to use lossy or lossless compression based on the needs of a situation • Argue if current copyright laws are helping or harming society using evidence from an article • Explain how copyright and Creative Commons Licenses can be applied to digital works of creativity
Key Vocabulary: Binary, Bit, Byte, Decimal, Octal, Hexadecimal, Overflow, Round-off Error, Text, Ascii, Abstraction, Pixel, RGB, Digital/Analog, Sampling, Lossy Compression, Lossless Compression, Intellectual Property, Copyright, Creative Commons	

Assessment Evidence	
Performance Tasks: Digital Information Dilemmas Project:**TI3(9-12) and AA1(9-12)** ● Students tackle the question of whether digitizing information has made the world a better or worse place. ● Students place stickies on a spectrum of "worse" to "better" to state their opinion prior to doing the activity. ● Students then choose an article they are interested in reading using a process the class completed collectively in the previous lesson. ● Students design and make an artifact to present their findings. ● Students identify the benefits and harms highlighted in the article and make an overall claim about whether the world has been made better or worse through the digitization of information. ● Students update the position of their stickies on the "better" to "worse" spectrum and discuss whether and why they changed their opinion.	**Other Evidence:** Unit 1 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 1 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.

Learning Plan

This unit explores the technical challenges and questions that arise from the need to represent digital information in computers. Learn how complex information like numbers, text, images, and sound are represented in bits, how compression works, and the broader social impacts of digitizing the world's information.

- Welcome to CSP- Welcome to Computer Science Principles! The first lesson is about getting students excited about the course and connecting their own personal interests to computer science. Students are asked to share something they know a lot about and teach it to a small group. Groups make a “rapid” prototype of an innovative idea and share it. Students watch a brief video about computing innovations. The lesson ends with students logging into the Code.org CSP course web site, and answering a brief prompt about what “computer science” means to them. This activity plants the initial seed for students to think about the ways in which they might be able to solve some problems relevant to their lives with technological innovations. **TI3(9-12)**
- Representing Information- Using everyday materials, students create devices for sending information to a partner, which introduces the concept of sending bits of information from one place to another. Each group then uses its device to send an answer to a question. Following this, students modify their devices to answer more complex answers, responding with one of four possible messages, then one of eight possible messages, then one of sixteen possible messages. This lays the foundation for understanding how complex information is represented in computers using a combination of bits. **TI3(9-12)**
- Circle Square Patterns- Students will create rules for ordering patterns of circles and squares. Students generate all possible messages

with three place values, then create rules that explain how they ordered each message. Emphasis is placed on creating clear rules so that, if another group were to follow the rules, they would generate the same list in the same order. Using these rules, students then try to list all possible messages with four place values. As the lesson concludes, students share their rules with classmates. This lesson acts as a bridge to the next lesson where binary is formally introduced and practiced.**TI3(9-12)**

- Binary Numbers- In this lesson, students will practice representing numbers in binary (base 2), transitioning from the circle-square representations they made in the last lesson. Students will create and use a "Flippy Do", a manipulative which helps students convert between binary (base 2) and decimal (base 10) numbers. They will practice converting numbers and explore the concept of place value in the context of binary numbers.**AA1(9-12)**
- Overflow and Rounding- Students extend their understanding of the binary number system by exploring errors that result from overflow and rounding. They use the binary odometer widget and develop their own systems for representing fractional amounts using the Flippy Do. Students discover the limitations of creating numbers that are “too big” or “too small” to count. They learn that, while a number system is infinite, the physical representation of numbers requires place values -- which are finite, and limit the ability to represent numbers.**AA1(9-12)**
- Representing Text- In this lesson, students create a system for representing text using only numbers while communicating with each other. They are only allowed to send numbers back-and-forth, so they must create a system to translate between number and character. Most importantly they should understand the challenges or principles that led to the creation of these systems and that these systems are somewhat arbitrarily created to solve a shared problem. They work not because there was "one right answer" but because many people agreed to use them. At the end of the main activity they briefly review the ASCII system for representing text. The wrap up discussion emphasizes how all of the concepts thus far have ‘built’ on each other and introduces the concept of abstraction to describe this progression.**AA1(9-12)**
- Black and White Images- Students explore how black and white images are represented. Students use the black and white pixelation widget to represent each pixel of an image with black or white light. They learn how to sample an analog image using small squares of uniform size (each represented with a black or white value) and reflect on the pros and cons of choosing a smaller or larger square size when sampling.**AA1(9-12)**
- Color Images- This is a second opportunity for students to interact with the Pixelation Widget, but this time they will work with color pixels. Students start off learning that each pixel uses red, green, and blue lights that can be turned on or off using bits. They will create more color variants using an increasing amount of bits per pixel, and apply their learning by approximating an analog color image using the widget. These images are produced using layers of abstraction, with each layer relying on the other to perform its process.**AA1(9-12)**
- Lossless Compression- Students use the Text Compression Widget to experiment with compressing songs and poems and try to find their ‘personal best’ compression. A video introduces important vocabulary for the lesson and demonstrates the full features of the widget. Students pick a text they think will be ‘easy’ to compress and one they think will be ‘difficult’, paying attention to why some texts might be more compressible than others. As a wrap-up, students discuss what factors make some texts more compressible than others. The widget is just one example of lossless compression and students aren’t expected to master specific compression strategies - instead, they should understand that lossless compression uses less data and still lets them re-create the original information.**TI3(9-12)**
- Lossy Compression- Students are introduced to lossy compression via the Lossy Text Compression widget. They apply this concept and their prior knowledge of sampling to create their own lossy compressions of image files using the Lossy Image Widget. A theme throughout the lesson is that lossy compression can greatly reduce the file size, but it can also greatly reduce the quality and it’s important to find that balance between quality and file size. The real challenge here is finding where that line is - how much can we compress but still

keep it recognizable? Students then discuss several practical scenarios where they need to decide whether to use a lossy or lossless compression algorithm. The lesson ends with a discussion of the situations where lossless compression is important and the situations where lossy compression is important.**TI3(9-12)**

- Intellectual Property- Students are asked to reflect on who owns their creative works from this class, such as their pixel images, before reading an article describing how ownership can become complicated as analog works become digital artifacts. After reading the article, students watch several videos explaining copyright and introducing them to the Creative Commons. Students then re-read the article answering three questions about the benefits, harms, and impacts of current copyright policy. Students use their new understanding of copyright to form an opinion about current copyright policies and create a small poster justifying their opinion with a quote from the article. This lesson is also a scaffold to the larger project that begins after this lesson which includes several tasks that are also a part of this lesson such as, annotating an article, answering questions, and forming an opinion using the article as evidence.**TI3(9-12)**

Teacher Resources:
Code.org online curriculum
http://chortle.ccsu.edu/Java5/index.html#07
Java Runtime Environment
Java Development Kit

Unit 2 - The Internet

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
2-NI-04 - Model the role of protocols in transmitting data across networks and the Internet.
3A-NI-04 - Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
3B-NI-03 - Describe the issues that impact network functionality (e.g., bandwidth, load, delay, topology).

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
TI3(9-12): I can formulate and investigate probing questions to further my learning.

Understandings: Students will understand that...

- The internet is a connected network of computing devices that uses an agreed upon series of protocols for the transfer of information.
- Computer systems and networks facilitate the transfer of data.
- Parallel and distributed computing leverage multiple computers to more quickly solve complex problems or process large data sets.

Essential Questions:

- What is the internet and how does it work?
- When an internet service outage occurs in a different part of your town or city, how are you still able to access the internet?

Students will know...

- The internet is a network of computing devices.
- Like postal addresses, IP addresses allow computing devices to identify one another.
- DNS matches names like www.google.com with the ip address at which the data for the site is located.
- Protocols are the key to making sure all computing devices can interact with others on the internet.
- Packets contain data sent over the internet.
- An email or download could require very many packets of data.
- Redundancy allows systems to be fault tolerant.
- Different protocols for sending data exist and are more or less appropriate in different situations.

Students will be able to...

- Identify questions they have about how the Internet works
- Use the Internet Simulator to communicate information with a partner
- Explain how computing devices can be connected to form a network
- Identify the path(s) connecting two devices in a simulated network
- Describe the way the Internet Protocol helps uniquely identify one another on the Internet
- Explain the need for open and shared protocols for communicating on the Internet
- Describe how the redundant nature of networks can lead to

	dynamic, fault tolerant routes • Explain how data is routed through the Internet • Describe how information flows through the Internet as a datastream of packets • Explain how packet numbering and re-ordering can allow for large messages to reliably be sent even if packets are dropped or arrive out of order • Explain the differences between the Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) • Describe how HTTP is used for sharing the files and pages that make up the World Wide Web • Describe how the Domain Name System helps the Internet scale by allowing devices to find the IP addresses associated with a domain name • Explain how different layers of protocols on the Internet build upon and rely on one another
Key Vocabulary: Computing Device, Computing System, Computing Network, Path, Bandwidth, Internet, Protocol, IP Address, Internet Protocol, Router, Redundancy, Fault Tolerant, User Datagram Protocol(UDP), Transmission Control Protocol (TCP), Datastream, Packet, Packet Metadata, Scalability, Domain Name System(DNS), World Wide Web, Hypertext Transfer Protocol(HTTP)	
Assessment Evidence	
Performance Tasks: Internet Dilemmas Project:**TCC2(9-12) and TI3(9-12)** Students work on a two-day project exploring a dilemma at the intersection of the Internet and society. In this project, students explore a relevant Internet dilemma: Net Neutrality, Internet Censorship, or the Digital Divide. Students apply their knowledge of how the Internet works to address the core question related to their chosen dilemma. This project addresses the "so what" question - why is it important to learn about how the Internet works?	**Other Evidence:** Unit 2 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 2 Assessment - This end-of-the-unit task assesses

	student understanding through a variety of multiple choice questions that cover topics from this unit.

Learning Plan

This unit reveals how the Internet was designed to connect billions of devices and people to one another. Learn how the different protocols of the Internet work and actually build them yourself using the Internet Simulator. Then consider the impacts the Internet has had, both good and bad, on modern life.

- Welcome to the Internet- After a short transition from representing information in Unit 1 to communicating information in Unit 2, students take time to think about their knowledge of the Internet and how it works. Following this, students are introduced to a new widget: The Internet Simulator which they will use throughout this unit to explore the inner workings of the Internet. Students should leave this lesson primed to know more about the Internet. **TCC2(9-12)**
- Building a Network- In this lesson, students are formed into groups of 5-7 and given string so they can connect themselves together to form a computer network. Students are given several specific networks to form, along with several guidelines for how to best form computer networks. Students are also forced to wrestle with conflicting guidelines in determining the 'best' way to connect together to form a network, and will need to justify why they chose the networks that they did. **TCC2(9-12)**
- The Need for Addressing- Students complete a scheduling challenge three times, once unplugged, and twice on the Internet Simulator, to explore the need for addressing messages online. Students first complete a challenge where they are allowed to talk to one another to fill out a weekly schedule. They then move on to a version of the Internet Simulator where all of their messages are "broadcast" or sent to everyone in the same simulator room. This challenge forces students to develop shared rules for communicating to complete the scheduling activity a second and then third time. The wrap up helps students connect their experiences to real-life rules, or protocols, used on the Internet for addressing messages.**TI3(9-12)**
- Routers and Redundancy- Students spend most of today's lesson in an updated Internet Simulator that lets students send messages with a dedicated To and From IP Address. Students start by connecting to a dedicated router and sending messages only to each other. They look at the router logs to find other students on different routers, then send messages to those students. They look at the router logs again to notice that messages are being passed between routers in order to reach their destination. Students continue to send messages and view the logs one last time to notice that the messages are also taking different paths to reach the same destination. The lesson wraps-up by introducing new vocabulary and using these words to summarize today's activity.**TI3(9-12)**
- Packets- Students learn that large messages sent over the Internet are actually divided into individual packets and explore the challenges this creates. First students explore a version of the Internet Simulator that breaks messages into packets to get a sense for how it works. Students then use an activity guide that walks them through the challenges that dropped or out-of-order packets create. They then design their own protocol that addresses these challenges. At the end of the lesson students watch a video and learn the User Datagram Protocol (UDP) and The Transmission Control Protocol (TCP), two different protocols for sending messages broken into packets.**TI3(9-12)**
- HTTP and DNS- Students conclude their study of the layers of the Internet by learning about two top-level protocols, HTTP and DNS. The lesson begins with a review of the layers students have already learned, namely the physical Internet, IP, and TCP / UDP. The lesson then dives into the core of the unit which is "What happens when I type an address into my browser?" Students will complete two brief activities,

one unplugged, and one plugged, that explore how the DNS works. Students then watch videos explaining how both DNS and HTTP work, taking notes in a provided activity guide. The lesson concludes with a review of how the different layers of the Internet work.**TCC2(9-12)**
Teacher Resources: Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 3 - Intro to App Design

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3A-AP-16 - Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions.
2-AP-17 - Systematically test and refine programs using a range of test cases.
3A-AP-13 - Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests.
3A-AP-21 - Evaluate and refine computational artifacts to make them more usable and accessible.
3A-AP-22 - Design and develop computational artifacts working in team roles using collaborative tools.
3A-AP-23 - Document design decisions using text, graphics, presentations, and/or demonstrations in the development of complex programs.
3A-CS-03 - Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

Understandings: Students will understand that...

- Incorporating multiple perspectives through collaboration improves computing innovations as they are developed.
- Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.

Essential Questions:

- How does the interactive design of programs and apps impact its user base?
- What are some ways you can collect additional feedback on your program to use for improvements?

Students will know...

- Collaboration is an important element of designing computer software.
- User feedback will result in computer software that best meets the needs of its intended audience.
- A user interface is the most common field for input and output on today’s modern day applications.
- Using variable names and element ids makes coding, and reading code, easier.

Students will be able to...

- Identify the inputs of an app
- Identify the outputs of an app
- Identify the purpose of an app
- Set up the User Interface of an app including buttons, text, and images
- Use meaningful names to for element ids
- Explain the qualities that differentiate natural languages and programming languages

• Many programming languages exist, though many of the core elements are the same. • Comments clarify the purpose of code segments • Debugging is critical to making sure that software works as intended when released. • Sequentiel code executes in a top-down order. • Event-driven code executes as conditions are met.	• Justify the existence of programming languages to precisely communicate instructions • Define a program as a sequence of commands that are executed or run by a computer • Define comments as notes or documentation into a program that do not affect how the program executes • Explain the differences between how sequential and event-driven programs execute • Debug simple sequential and event-driven programs • Use the debugging process and Identify specific best practices for debugging programs • Use the speed slider, break points, and documentation as part of the debugging process
Key Vocabulary: App, User Interface, Input, Output, Design, Implementation, Program Statement, Program, Sequential Programming, Event Driven Programming, Debugging, Documentation, Comment, Pair Programming	
Assessment Evidence	
Performance Tasks: Designing an App Project:**CCE2(9-12) and CCE3(9-12)** • Students brainstorm app ideas and sketch out user interfaces • Students follow the app development process outlined in their App Development Guide • Students apply Pair Coding • Students watch other groups test their apps and collect feedback that will be used to make updates. • Students review other apps that classmates made and complete a short set of reflection prompts before submitting their projects.	**Other Evidence:** Unit 3 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 3 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.

Learning Plan
This unit is an introduction to programming and app design with a heavy focus on important skills like debugging, pair programming, and user testing. Learn how to design user interfaces and write event-driven programs in App Lab and then design a project that teaches your classmates about a topic of your choosing. ● Introduction to Apps- Students explore and investigate what makes an app an app. They begin by looking at and discussing five different apps. Following this, students watch a video explaining the basics of how computers work. Finally students return to the apps and consider the various inputs and outputs.**CCE2(9-12) and CCE3(9-12)** ● Introduction to Design Mode- Students work through a progression of levels to build an understanding of how to use Design Mode to layout an app. The final level has students setting up the screen of an app by attempting to copy an image of an app. **CCE2(9-12) and CCE3(9-12)** ● The Need for Programming Languages- In this lesson students explore the challenges of clearly communicating instructions. They build a small arrangement of blocks (LEGO® pieces or paper cutouts) and then create text instructions a classmate could follow to construct the same arrangement. Groups then trade instructions to see if they were clear enough to allow reconstruction of the original arrangement. The wrap-up discussion is used to highlight the inherent ambiguities of human language and call out the need for the creation of a programming language which leaves no room for interpretation.**CCE2(9-12) and CCE3(9-12)** ● Intro to Programming- Students use and modify a series of simple apps to get familiar with a small set of programming commands. They observe the way the code runs by slowing down the code and compare programs that run all at once to those that respond to user actions like button clicks. At the end of the lesson students discuss what they observed and are introduced to some key vocabulary for describing the running of programs.**CCE2(9-12) and CCE3(9-12)** ● Debugging- In this lesson students practice using the different programming concepts that they were introduced to in the last lesson. To begin, however, they are introduced to the concept of debugging and are encouraged to use and reflect on this practice throughout the lesson. At the end of the lesson students share their experiences debugging as well as new realizations about programming.**CCE2(9-12) and CCE3(9-12)**
Teacher Resources: Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 4 - Variables, Conditionals, and Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
2-AP-11 - Create clearly named variables that represent different data types and perform operations on their values.
2-AP-19 - Document programs in order to make them easier to follow, test, and debug.
3B-AP-23 - Evaluate key qualities of a program through a process such as a code review.
2-AP-10 - Use flowcharts and/or pseudocode to address complex problems as algorithms.
3A-AP-15 - Justify the selection of specific control structures when tradeoffs involve implementation, readability, and program performance and explain the benefits and drawbacks of choices made.
2-AP-12 - Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
3B-AP-21 - Develop and use a series of test cases to verify that a program performs according to its design specifications.
3A-AP-17 - Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
3B-AP-14 - Construct solutions to problems using student-created components, such as procedures, modules and/or objects.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...
- The way statements are sequenced and combined in a program determines the computed result.
- Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.

Essential Questions:
- How can we store data in a program to solve problems?
- In what ways can we reduce code complexity through the use of conditional statements and functions?

Students will know...
- Numbers and strings are two different types of values
- Expressions evaluate to a single new value
- Global Variables are permanent and can be referenced anywhere in program code.
- Local variables are temporary and only exist within the scope of their declaration.
- A boolean value is a data type that is either true or false.
- Each side of a Boolean expression is reduced to a single value.

Students will be able to...
- Evaluate expressions that include numbers, strings, arithmetic operators, Boolean values, comparison operators, and logical operators
- Trace simple programs that use variables, expressions, and variable assignment.
- Use appropriate vocabulary to describe variables, expressions, variable assignment, Boolean expressions, conditional statements, functions

• A truth table can allow us to determine all truth values for a Boolean expression. • A flowchart can illustrate the steps of making a decision with a boolean expression. • A conditional statement is used to choose between two or more options. • Conditional statements can be nested to handle multiple possible results. • Functions can be used to avoid unneeded code reuse. • Functions are an abstraction for multiple commands in code. • Event based functions occur only when specific conditions are met.	• Explain the purpose of those programming patterns with variables both in terms of how they work and what they accomplish • Identify common programming patterns when using variables as part of an app • Modify apps that make use of common programming patterns with variables to adjust their functionality • Debug programs that use variables and expressions • Write programs that use variables and expressions with the support of sample code. • Implement programming patterns with variables to develop a functioning app • Recognize the need for programming patterns with variables as part of developing a functioning app • Use debugging skills as part of developing an app • Write comments to clearly explain both the purpose and function of different segments of code within an app • Explain the purpose of those programming patterns with boolean expressions and conditional statements both in terms of how they work and what they accomplish • Identify common programming patterns using boolean expressions and conditional statements • Modify apps that make use of common programming patterns with boolean expressions and conditional statements to adjust their functionality • Debug programs that use boolean expressions. conditional statements, and functions • Write programs that use boolean expressions, conditional statements, and functions with the support of sample code. • Implement programming patterns with boolean expressions and conditionals statements to develop a functioning app • Recognize the need for programming patterns with Boolean expressions and conditional statements as part of developing a functioning app • Write comments to clearly explain both the purpose and function of different segments of code within an app • Describe the way a function call interrupts the normal flow of execution within a program

	• Modify programs that declare and call functions to adjust their functionality • Trace the flow of execution in programs that declare and call functions • Identify opportunities to use functions to reduce repeated code within a program • Implement a function using programming patterns while developing a functional app • Recognize the need for a function to reduce repeated code while developing a functional app
Key Vocabulary: Expressions, Variable, Assignment Operator, String, Concatenation, Global Variable, Local Variable, Boolean Expression, Comparison Operator, Logical Operators (&&, ||, !), Truth Table, If Statement, If Else-If Statement, Modulus Operator (%), Syntax Error, Logic Error, Function, Function Call, Event Based Function	
Assessment Evidence	
Performance Tasks: Decision Maker App Project:**TI1(9-12) and AA1(9-12)** Using a Project Planning Guide, students work through the stages of creating an app from scratch. • Students complete the planning phase. • Students translate the plans they documented in Part 1 of the Practice PT to a working program in App Lab through a series of steps. • Students work with classmates to review and update the functionality of their apps before submitting the final project.	**Other Evidence:** Unit 4 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 4 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.
Learning Plan	
This unit explores how variables, conditionals, and functions allow for the design of increasingly complex apps. Learn how to program with these three new concepts through a sequence of collaborative activities. Then build your own decision maker app to share with friends and help them make a decision.	

- Variables Explore- To begin the lesson students explore sample apps similar to the ones they'll be able to build by the end of the unit. Then students complete an unplugged activity with plastic baggies and sticky notes to build a mental model of how variables are used to move and store information. The lesson ends with a synthesizing discussion and students adding key vocabulary to their journal.**AA1(9-12)**
- Variables Investigate- In this lesson students work with partners to investigate several versions of the "Thermostat App" to understand how variables store and update information. To begin, students examine a version of the app where the temperature displayed changes each time a button is clicked. The next two versions of the app demonstrate how variables can store strings. Students learn about the patterns they are observing, specifically "Counter Pattern with Event" and "Variables with String Concatenation Pattern". To conclude the lesson, students review and discuss the programming patterns that they will make use of in the programs they write. **AA1(9-12)**
- Variables Practice- In this lesson students spend most of their time practicing using the skills and processes they have learned about variables. At the conclusion of the lesson students discuss the main things they realized and still have questions about at the conclusion of this lesson.**TI1(9-12)**
- Variables Make- Using Programming Patterns and a step-by-step approach students make their own version of a Photo Liker app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. A progression of levels guides students on the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**
- Conditionals Explore- Students learn the basics of conditionals through an unplugged activity using the sticky notes and plastic baggies from the Variables Explore lesson. The activity provides students a physical mental model they will be able to use when they start programming with conditionals in the subsequent lessons. Flowcharts are introduced as a way to understand how computers make decisions using Boolean expressions. **AA1(9-12)**
- Conditionals Investigate- In this lesson students work with partners to investigate three versions of the "Lemon Squeeze" app to understand how boolean expressions and conditional statements allow programs to make decisions. In each guided investigation students first watch a short video on a concept, then use a working app to predict how new features work, then investigate the code to see how those features are implemented, and finally modify the code to add expanded features. To conclude the lesson, students review and discuss common programming patterns with conditionals.**AA1(9-12)**
- Conditionals Practice- In this lesson students spend most of their time practicing using the skills and processes they have learned about conditionals. At the conclusion of the lesson students discuss the main things they realized and still have questions about at the conclusion of this lesson.**TI1(9-12)**
- Conditionals Make- Using Programming Patterns and a step-by-step approach students make their own version of a Museum Ticket Generator app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. A progression of levels guides students on the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**
- Functions Explore/Investigate- Students begin the lesson by considering two ways to write out the lyrics of a song, one that includes a lot of repeated text and one that does not. After exploring this example students complete a series of investigation activities in which functions have been used to remove repeated code from a program. At the conclusion of the lesson students discuss the concept of a function to synthesize their learning and add definitions to their journal.**AA1(9-12)**
- Functions Practice- In this lesson students spend most of their time practicing using the skills and processes they have learned about

functions. At the conclusion of the lesson students discuss remaining questions in anticipation of their Make project in the following lesson.**TI1(9-12)**

- Functions Make- Using Programming Patterns and a step-by-step approach students make their own version of a Quote Maker app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. Students use an Activity Guide to go through the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**

Teacher Resources:
Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 5 - Data

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3A-DA-11 - Create interactive data visualizations using software tools to help others better understand real-world phenomena.
3B-DA-05 - Use data analysis tools and techniques to identify patterns in data representing complex systems.
3B-DA-06 - Select data collection tools and techniques to generate data sets that support a claim or communicate information.
3A-DA-10 - Evaluate the tradeoffs in how data elements are organized and where data is stored.
3B-AP-08 - Describe how artificial intelligence drives many software and physical systems.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.
TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.

Understandings: Students will understand that...

- We live in an era where data is so plentiful as to seem overwhelming and it has become increasingly important to know how to process and interpret it correctly.
- All forms of data visualization are only as good as the practices used to create them.

Essential Questions:

- When is it more appropriate to use a computer to analyze data than to complete the analysis by hand?

Students will know…

- Programs can help process data so we can understand it and learn from it.
- Correlation does not imply causation.
- Charts and other visualizations can help both find and communicate what we’ve learned from data.
- Bar charts and histograms are two common chart types for exploring one column of data in a table.
- We can develop insights and knowledge about our world from manipulating and visualizing data, in particular by finding patterns.
- When investigating two columns of data we can observe patterns as different values move together.

Students will be able to…

- Differentiate between what data shows and why that might be the case
- Explain the usefulness of metadata
- Create a bar chart, histogram, crosstab and scatter chart in App Lab's data visualizer
- Draw conclusions by reading bar charts, histograms, crosstab and scatter charts
- Explain the reasons that someone would create either a bar chart, histogram, crosstab and scatter chart in order to explore a single column of data
- Create filtered charts that answer specific questions
- Explain why data needs to be cleaned

• Machine Learning occurs when we differentiate on some variable with large amounts of data. • Artificial Intelligence is the result of computers using machine learning to make seemingly informed decisions. • Algorithmic Bias occurs when data used in machine learning is not a fair representation of all possible appropriate data.	• Use the Data Visualizer to filter data • Define and explain the impacts of crowdsourcing, crowdfunding, and citizen science • Explain the impact of open data on scientific research and discovery • Explain why in some contexts large amounts of data need to be analyzed in parallel and scalable systems • Explain ways that designers and developers can consider the potential effects of their programs • Reason about how human bias plays a role in machine learning. • Reason about which types of tasks are should not be completed by an algorithm
Key Vocabulary: Data, Correlation, Causation, Metadata, Bar Chart, Histogram, Cleaning Data, Filtering Data, Data Analysis, Crosstab Chart, Scatterplot, Open Data, Citizen Science, Crowdsourcing, Big Data, Machine Learning, AI, Algorithmic Bias	
Assessment Evidence	
Performance Tasks: Tell a Data Story Project:**TCC2(9-12) and TCC4(9-12)** This is a two-day project where students use the Data Analysis Process to tell a data story. Students will: • Create an effective visualization • Describes new insights or decisions that can be made based on a visualization • Explain information in a visualization • Follow the Data Analysis Process to tell a data story • Follow the Data Analysis Process to tell a data story • Recognize and explain potential bias in a dataset or interpretation • Write a short explanation of a data set referencing the metadata	**Other Evidence:** Unit 5 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 5 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.

Learning Plan
In this unit learn how data analysis helps turn raw data into useful information about the world. Learn how to use data visualization to find patterns inside of data sets and learn how this data analysis process is being used in contexts like open data or machine learning to help make decisions or learn more about our world. In the unit project, you'll analyze a dataset of your choosing and present your findings. ● Learning from Data- In this lesson students explore the “What’s Going on in this Graph?” site in order to tell a "data story" which explains both what the data shows and why that might be. Following this, students are introduced to the concept of metadata and look for the metadata of datasets on App Lab.**TCC4(9-12)** ● Exploring One Column- Students will practice making conclusions from charts and learn to use the Data Visualizer in App Lab to create two different kinds of charts: a bar chart, and a histogram. The lesson begins with a quick prompt to review the reasons charts are useful for looking at data. Students then practice reading a bar chart and review the kinds of questions it is and is not useful for answering. Afterwards they build different bar charts in the Data Visualizer and discuss why some are or are not useful. Afterwards they learn how to make histograms for building charts in instances where bar charts may not be useful. Students record their work on an activity guide. The lesson concludes with a brief review of what they learned and an introduction to the Data Analysis Process.**TCC2(9-12)** ● Filtering and Cleaning Data- In this lesson, students explore the challenges of working with a messy dataset. First students learn how to identify issues using the Data Visualizer, and then manually clean the data. Following this, students learn about the filtering tools in the Data Visualizer, and use a guided activity to answer data questions that require filtering a dataset. **TCC4(9-12)** ● Exploring Two Columns- Students will practice making conclusions from charts and learn to use the Data Visualizer in App Lab to create two different kinds of charts, a cross tab, and a scatterplot. Students will practice reading each type of chart before learning to make them in the Data Visualizer. Students will track their work using a provided activity guide. The lesson concludes with a review of key takeaways.**TCC2(9-12)** ● Big, Open, and Crowdsourced Data- Students will complete a jigsaw of three different topics at the intersection of data, computing, and global impacts. These are topics, big data, crowdsourcing, and open data. Students will watch videos or listen to audio recordings about the different topics. Groups will each complete an activity guide about their topic before having individuals from each group share out their findings. The lesson concludes with a review of key points.**TCC4(9-12)** ● Machine Learning- In this lesson, students are introduced to the concepts of Artificial Intelligence and Machine Learning using the AI for Oceans widget. First students classify objects as either "fish" or "not fish" to attempt to remove trash from the ocean. Then, students will need to expand their training data set to include other sea creatures that belong in the water. In the second part of the activity, students will choose their own labels to apply to images of randomly generated fish. This training data is used for a machine learning model that should then be able to label new images on its own.**TCC2(9-12)** ● Algorithmic Bias- In this lesson, students will practice cropping images to uncover the bias underlying the Twitter cropping algorithm. Then, students will read and watch a video about the discovery of this biased algorithm. Finally, students will discuss ways to recognize and reduce bias along with analyzing Twitter's response to the allegations of bias in their cropping algorithm.**TCC4(9-12)**
Teacher Resources: Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 6 - Lists, Loops, and Traversals

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3A-AP-14 - Use lists to simplify solutions, generalizing computational problems instead of repeated use of simple variables.
3B-AP-23 - Evaluate key qualities of a program through a process such as a code review.
3A-AP-15 - Justify the selection of specific control structures when tradeoffs involve implementation, readability, and program performance and explain the benefits and drawbacks of choices made.
3A-DA-12 - Create computational models that represent the relationships among different elements of data collected from a phenomenon or process.
3B-AP-10 - Use and adapt classic algorithms to solve computational problems.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...
- To find specific solutions to generalizable problems, programmers represent and organize data in multiple ways.

Essential Questions:
- What types of abstractions are available to programmers and how are they used?
- What common algorithms allow us to process data collections?

Students will know...
- A list is an ordered collection of elements.
- An element is an individual value in a list that is assigned a unique index.
- An index is a common method for referencing the elements in a list or string using numbers.
- The length of a list is how many elements it contains.
- Lists can grow or shrink as elements are added or removed.
- Lists are an example of data abstraction.
- Loops allow for repeated behavior.
- Loops can allow programs to traverse through all elements in a list.
- A while loop repeats until a specific condition is met.
- A for loop puts all three key elements of a loop into a single line

Students will be able to...
- Use an index to reference specific elements in a list.
- Use appropriate vocabulary to describe lists, loops, and traversals.
- Explain the purpose of programming patterns with lists both in terms of how they work and what they accomplish
- Identify common programming patterns using lists, loops, and traversals.
- Modify apps that make use of common programming patterns with lists, loops, and traversals to adjust their functionality
- Accurately use list operations including accessing, inserting, and removing elements
- Correctly set up a list in a program
- Debug programs with lists, loops, and traversals.

of code. ● Bugs can cause loops to repeat infinitely. ● We use a for loop to traverse a list, one element at a time.	● Implement programming patterns with lists, loops, and traversals to develop a functioning app ● Recognize the need for programming patterns with lists, loops, and traversals as part of developing a functioning app ● Use debugging skills as part of developing an app ● Write comments to clearly explain both the purpose and function of different segments of code within an app ● Identify the exit point of a loop. ● Trace a simple program with a loop ● Read programs that use for loops ● Understand the parts of a for loop ● Update the Boolean expression in a for loop to change how many times the loop runs ● Use a for-loop to update multiple screen elements at once ● Understand how to use a loop to traverse a list ● Write programs that use list traversals, including the filter and reduce patterns, with the support of sample code
Key Vocabulary: List, Append, Insert, Remove, Element, Index, Loop, While Loop, For Loop, Iteration, Infinite Loop	
Assessment Evidence	
Performance Tasks: Hackathon Project:**TI1(9-12) and AA1(9-12)** ● Students determine a dataset to design the app around, and create a paper prototype. ● Students fill out tables of information on element IDs and programming constructs before each tackling a different role in the project as a designer or a programmer. ● Students build their apps and complete a Written Response, individually answering prompts about the project. ● Students share their apps during a gallery walk.	**Other Evidence:** Unit 6 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 6 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions

	that cover topics from this unit.

Learning Plan

This unit introduces lists, loops, and traversals, and explores the way they can be used to build apps that store and process large amounts of information. Learn to program with the data library in App Lab and complete a 5-day hackathon project at the end of the unit where you can design a program about any topic of your choosing.

- Lists Explore- Students will learn the ways that lists are created, accessed, and changed through a teacher-guided activity using plastic baggies and pieces of paper. The lesson begins with a brief reflection on the value of lists. Students then complete the main activity which introduces the syntax to use lists and the ways they can be used. To wrap up, students watch two short videos on lists and record the main concepts in their journals.**AA1(9-12)**
- Lists Investigate- In this lesson students work with partners to investigate three different apps that use lists. Students first explore all three apps without seeing the code to notice similarities and predict how they will work. Then they explore the code itself and make additions and modifications to the apps. Students are also introduced to the getColumn command and how to use it to populate lists from the datasets in the AppLab Data Library. To conclude the lesson, students review and discuss common programming patterns with conditionals.**AA1(9-12)**
- Lists Practice- Practice the basics of lists including creating lists and accessing, inserting, and removing elements from lists. **TI1(9-12)**
- Lists Make- Using Programming Patterns and a step-by-step approach students make their own version of a Reminder app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. Students use an Activity Guide to go through the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**
- Loops Explore- Students begin the lesson by discussing the purpose of loops before completing the unplugged activity. This activity involves moving a "robot" around a game board while practicing tracing blocks of code by hand. To conclude, the lesson is wrapped up with a vocabulary discussion and a video. **AA1(9-12)**
- Loops Investigate- Students practice using the for loop in order to repeatedly run pieces of code. The lesson begins with a quick investigation of an app that flips coins. After that code investigation students complete another investigation with an app that uses loops to update screen elements. **AA1(9-12)**
- Loops Practice- Students practice the basics of loops including using while loops, for loops, and updating multiple screen elements with a for loop. Along the way students develop debugging practices with loops.**TI1(9-12)**
- Loops Make- Using Programming Patterns and a step-by-step approach students make their own version of a Lock Screen Maker app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with minimal starting code. A progression of levels guides students on the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**
- Traversals Explore- The lesson begins with a quick review of lists and loops before moving into the main activity. Here students explore the concept with the Traversal Machine, a physical model of traversal using a for loop. **AA1(9-12)**

- Traversals Investigate- In this lesson students work with partners to investigate three different apps that use traversals to access items in a list. Students first explore all three apps without seeing the code to notice similarities and predict how they will work. Then they explore the code itself and make additions and modifications to the apps. To conclude the lesson, students review and discuss common programming patterns with traversals.**AA1(9-12)**
- Traversals Practice- Students practice traversing lists, filtering and reducing lists, and using the data import tools. Along the way students develop debugging practices with traversals.**TI1(9-12)**
- Traversals Make- Using Programming Patterns and a step-by-step approach students make their own version of a Random Forecaster app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. Students use an Activity Guide to go through the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**

Teacher Resources:
Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 7 - Parameters, Return, and Libraries

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
2-AP-14 - Create procedures with parameters to organize code and make it easier to reuse.
3B-AP-23 - Evaluate key qualities of a program through a process such as a code review.
3B-AP-16 - Demonstrate code reuse by creating programming solutions using libraries and APIs.
2-AP-17 - Systematically test and refine programs using a range of test cases.
3A-AP-18 - Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)
TI1(9-12): I can implement a realistic plan and adapt when necessary to achieve my goals.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...

- Programmers break down problems into smaller and more manageable pieces.
- By creating procedures and leveraging parameters,programmers generalize processes that can be reused.
- Procedures allow programmers to draw upon existing code that
- has already been tested, allowing them to write programs more quickly and with more confidence.

Essential Questions:

- How do programmers utilize the work of one another to improve software?
- What information is needed by, and provided by, a function?

Students will know...

- A parameter is a variable in a function definition.
- An argument is the value passed by a parameter.
- A return statement is used to return the flow of control to the point where the function was called as well as to return a value of an expression.
- Functions with parameters and return values help us simplify code.
- Functions can only return one value at a time.
- A function can have:

Students will be able to...

- Remove specifics from a function so that it can be used in a variety of situations
- Use appropriate vocabulary to describe parameters, return values, and libraries.
- Explain the benefits of using a function with a parameter or return value in the context of a specific program
- Identify situations in which a function with a parameter or return value would be necessary
- Modify programs that use functions with parameters and return

○ No parameters and return values ○ Parameters, but no return values ○ Return values, but no parameters ○ Parameters and return values ● Extracting shared features to generalize functionality is known as procedural abstraction. ● Using parameters allows a function to be generalized. ● Using procedural abstraction helps improve code readability. ● Procedural abstraction manages complexity by allowing code reuse. ● A library is a group of functions that may be used in creating new programs. ● An API specifies how functions in a library behave and can be used. ● Modularity is the subdivision of a computer program into separate subprograms.	● Use the modulus operator in a program ● Correctly set up a parameter in a function ● Correctly set up a return value in a function ● Write comments to explain the function purpose, parameters, and return values ● Debug programs that use functions with parameters and return ● Write functions with parameters and return values that meet a set of specified requirements ● Clearly write documentation for functions in a library ● Explain the process of preparing a function to be added to a library ● Explain the purpose of libraries as a way to simplify programs, allow for code reuse, and enable collaboration. ● Identify the use of a library within a program. ● Test the functions in libraries in order to understand their behavior ● Debug library code to remove any errors ● Read library code documentation in order to select the proper functions in the library to develop an app ● Test functions designed to be used in a library using different input values
Key Vocabulary: Argument, Parameter, Return, Procedural Abstraction, Library, Documentation, API, Modularity	
Assessment Evidence	
Performance Tasks: Make a Library Project:**TI1(9-12): and AA1(9-12)** ● Students design a library of functions. ● Students brainstorm common problems they've encountered while programming this year and begin to design functions that address those common problems. ● Students develop tests for their functions to make sure they return values as expected. ● Students exchange their library with a classmate for feedback. ● Students complete their library project, finalizing their code and	**Other Evidence:** Unit 7 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further

writing written responses explaining the way one of the functions in their library works.	discussion. Code.Org Unit 7 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.

Learning Plan

This unit introduces parameters, return, and libraries. Learn how to use these concepts to build new kinds of apps as well as libraries of code that you can share with your classmates. End the unit by designing a library of functions around any topic of your choosing.

- Parameters and Return Explore- Students work with envelopes and paper to model functions with parameters and return values. Students create their own physical function envelope for drawing a house that takes in different parameters, and then build another function to calculate and return the cost of building that house. **AA1(9-12)**
- Parameters and Return Investigate- In this lesson, students work with partners to investigate two different apps that use parameters and return values. **AA1(9-12)**
- Parameters and Return Practice- Students practice writing programs with parameters and return values by creating and debugging functions that use them.**TI1(9-12)**
- Parameters and Return Make- Students use the knowledge and skills they've developed working with parameters and return values to develop a Rock Paper Scissors App. Unlike typical Make projects, students are given a significant portion of the starter code but are given three functions with parameters and return values that they'll need to develop themselves. At the end students submit their apps which can be assessed using a provided rubric.**TI1(9-12)**
- Libraries Explore- Students learn the basics of libraries while building upon the envelope model of a function with a folder to represent a library. **AA1(9-12)**
- Libraries Investigate- In this lesson students work with partners to investigate two apps that use libraries as well as the code used to make a library. Through a series of guided discussions they learn how libraries help programmers simplify and reuse their code.**AA1(9-12)**
- Libraries Practice- Students practice important skills for working with libraries, including testing and debugging libraries, and using libraries to help develop apps. After a brief introduction to these practices by the teacher, students spend the majority of their time programming in a level progression.**TI1(9-12)**

Teacher Resources:
Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 8 - Cybersecurity and Global Impacts

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
2-IC-23 - Describe tradeoffs between allowing information to be public and keeping information private and secure.
3A-IC-29 - Explain the privacy concerns related to the collection and generation of data through automated processes that may not be evident to users.
3A-IC-30 - Evaluate the social and economic implications of privacy in the context of safety, law, or ethics.
3B-IC-28 - Debate laws and regulations that impact the development and use of software.
3A-NI-05 - Give examples to illustrate how sensitive data can be affected by malware and other attacks.
3A-NI-06 - Recommend security measures to address various scenarios based on factors such as efficiency, feasibility, and ethical impacts.
3A-NI-07 - Compare various security measures, considering tradeoffs between the usability and security of a computer system.
3B-NI-04 - Compare ways software developers protect devices and information from unauthorized access.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.

Understandings: Students will understand that...
- While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.
- The use of computing innovations may involve risks to personal safety and identity.

Essential Questions:
- Are innovators responsible for the harmful effects of their computing innovations even if those effects were unintentional? Why or why not?
- What data is generated by smartphones, and what is it being used for?

Students will know...
- Computing innovations can be physical or non-physical, and can be hardware, software, or concepts.
- Personally Identifiable Information is information that identifies, links, relates, or describes individuals.
- Technology enables the collection, use, and exploitation of information about, by, and for individuals, groups, and institutions.

Students will be able to...
- Define Personally Identifiable Information as information about an individual that identifies, links, relates, or describes them.
- Describe the different types of data that are used and collected by modern computing innovations
- Explain how disparate pieces of personal information can be combined to identify individuals or deduce other private information.

• Geolocation, cookies, and browsing history can all be used to create knowledge about an individual. • Many services and websites collect information that can be used to advertise to you by creating detailed profiles of who you are and what you like. • Once data is made digital, and especially once it's shared online, it's much harder to control. • Our private data powers a lot of computing innovations in ways we like. It makes products that are convenient, interesting, personal, useful, and often "free" because we "pay" with our data. • Not every effect of a computing innovation is anticipated in advance. • The balance between innovation, privacy, and security is continually being debated. • Significant legal and ethical concerns are raised by computing innovations. • Phishing is a technique that attempts to trick a user into providing personal information. • Keylogging is the use of a program to record keystrokes made by a computer user in order to gain fraudulent access to passwords and other confidential information. • Malware is software intended to damage a computing system or take partial control over its operation. • Encryption is a process for encoding messages. Decryption is a process that reverses encryption. • Multi Factor Authentication requires a user to prove their identity in two different ways.	• Assess a computing innovation to identify the specific privacy risks that could arise from the data it collects and stores. • Evaluate whether the benefits to society from a given computing innovation outweigh the privacy risks it poses. • Explain the risks to privacy that arise from using modern computing technology • Discuss the warning signals for these common security risks • Explain how these common security risks target people • Identify commons security risks: phishing, keylogging, malware, rogue access points • Confidently explain security risks and their impact on society • Describe the role human error played in the Equifax breach • Explain how computing tools can be used for decryption • Explain the difference between asymmetrical and symmetrical encryption • Identify why Caesar Cipher and Random Substitution Ciphers are not adequate for most encryption needs • Discuss the benefits of computer virus scanning software and the need for regular updates • Explain the benefits of multi factor authentication • Thoughtfully answer a stimulus question
Key Vocabulary: Computing Innovation, Data Policy, Privacy, PII, Geolocation, Cookies, Browsing History, Keylogging, Phishing, Malware, Rogue Access Point, Cybersecurity, Encryption, Decryption, Cipher, Caesar's Cipher, Public Key Encryption, Multi Factor Authentication	
Assessment Evidence	
Performance Tasks: Innovation Simulation Project:**TCC1(9-12), CCE1(9-12), and AA4(9-12)**	**Other Evidence:** Unit 8 Quiz - This quiz consists of a series of released problems from

• In this simulation, students take on the roles of different stakeholders in school communities converging at a convention where they eventually will deliver a proposal on the best computing innovation for the Future School. • Students research three different computing innovations and discuss these innovations with team members. • Students consider the unintended consequences their proposed innovations may have. • Students collectively narrow down the proposals of their team members to a set that seems most beneficial and presents a coherent vision for the Future School. • Students develop a shared artifact or presentation that presents their collective vision for the Future School. • Students get feedback on their group innovation proposal from one other group. • Students present the group Innovation Proposal and participate in a gallery walk of their classmates' projects, asking questions and reviewing any materials. • Students vote for the unified project and overall innovation they found most compelling.	AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 8 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.

Learning Plan

In this unit learn how computing innovations have impacted our world in beneficial and harmful ways. Learn how data can pose a threat to our privacy and security and the ways that encryption and other techniques are used to protect it. Throughout the unit participate in a "school of the future" conference in which you and a team make a proposal for how best to improve school life with computing innovations.

- Data Policies and Privacy- Students learn that the apps, websites, and other computing innovations they use every day require a lot of data to run, much of which they might consider to be private or personal. In the warm up students discuss which of a list of possible information types they consider private. Then students read the data policies from a website or service they use or know about. This investigation focuses on the kinds of data that are being collected, the way it's being used, and any potential privacy concerns that arise. A brief second activity reveals that even data that may not seem private, like a birthdate or zip code, can be combined to uniquely identify them. To conclude the lesson students prepare for a discussion in the following class about the pros and cons of sharing all this data by journaling about their current thoughts on whether the harms of giving up this privacy are outweighed by the benefits of the technology they power.**TCC1(9-12), CCE1(9-12), and AA4(9-12)**
- The Value of Privacy- Students develop their own opinions on the privacy tradeoffs inherent in many modern computing innovations. At the beginning of the lesson students watch a video on facial recognition technology that presents the tradeoffs between convenience and privacy and asks them to determine whether they think the tradeoff is worth it. Students respond to two videos that look at different tradeoffs between privacy, security, and convenience. Students then evaluate the website or app they investigated in the previous lesson

to determine if they think the benefits of the service outweigh the privacy risks. At the end of the class students discuss whether they generally think convenience outweighs privacy concerns.**TCC1(9-12), CCE1(9-12), and AA4(9-12)**

- Security Risks Part 1- Students investigate three different common security risks (phishing, keylogging, malware) in a jigsaw activity. In groups, students create Public Service Announcement slides warning of the dangers of their assigned security risk. Then students are grouped with students who investigate other security risks and are instructed to share their slide and give a voice over. The activity ends with the class coming together to discuss the security risks as a whole. **TCC1(9-12), CCE1(9-12), and AA4(9-12)**
- Security Risks Part 2- The lesson begins with a review of security risks by watching a video on Cybersecurity & Crime. Following this, the class does an investigation into the Equifax breach, and what went wrong. The class ends with a Kahoot quiz to review security risks. **TCC1(9-12), CCE1(9-12), and AA4(9-12)**
- Protecting Data Part 1- In this lesson students explore two different encryption widgets: The Caesar Cipher Widget and the Random Substitution Cipher. Afterwards, students watch a video that reviews these types of encryption and introduces a new concept: public key encryption. **TCC1(9-12), CCE1(9-12), and AA4(9-12)**
- Protecting Data Part 2- This lesson is a guided tour of multifactor authentication and software updates that students can use to protect their data. Following these discussions, students are introduced to a stimulus question where they will apply their knowledge gained throughout the unit to answer questions about an innovations data, benefits and harms, effects, and security or privacy concerns. **TCC1(9-12), CCE1(9-12), and AA4(9-12)**

Teacher Resources:
Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 9 - Algorithms

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3B-AP-10 - Use and adapt classic algorithms to solve computational problems.
3B-AP-11 - Evaluate algorithms in terms of their efficiency, correctness, and clarity.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.
AA2(9-12): I can assess my past successes and mistakes to change my approach.

Understandings: Students will understand that...

- There exist real-world problems that computers cannot solve, and even when a computer can solve a problem, it may not be able to do so in a reasonable amount of time.
- Algorithms allow for the generalization and repetition of a set of directions to complete a task or meet an objective.

Essential Questions:

- What common real-world problems can be solved with computer processed algorithms?
- Are there problems that no algorithm can solve?

Students will know...

- Algorithmic efficiency is a measure of how many steps are needed to complete an algorithm.
- Linear Search is a search algorithm which checks each element of a list, in order, until the desired value is found or all elements in the list have been checked.
- Binary Search is a search algorithm that starts at the middle of a sorted set of numbers and removes half of the data, repeating the process until the desired value is found or all elements have been eliminated.
- Some algorithms can be solved in reasonable time, some cannot. This refers to how viable it is to perform an algorithm considering present day computing powers.
- The Travelling Salesman Problem is an example of a problem that can't be solved in reasonable time.
- Heuristics are good for problems that cannot be solved in reasonable time and when a "good enough" solution is sufficient.

Students will be able to...

- Explain that some algorithms may look or operate differently but still solve the same problem.
- Explain that some problems may look different but be similar or look similar but be different.
- Explain the formal definitions of a problem, an algorithm, sequencing, selection, and iteration.
- Compare the efficiency of Linear Search and Binary Search
- Use Binary Search to determine if a number is in a list
- Use Linear Search to determine if a number is in a list
- Explain how both formal mathematical reasoning and informal measurement can be used to determine an algorithms efficiency
- Explain the difference between problems that run in a reasonable time and those that do not
- Determine if an algorithm runs in unreasonable time.
- Develop a heuristic to solve a problem.
- Distinguish between decision problems and optimization problems.

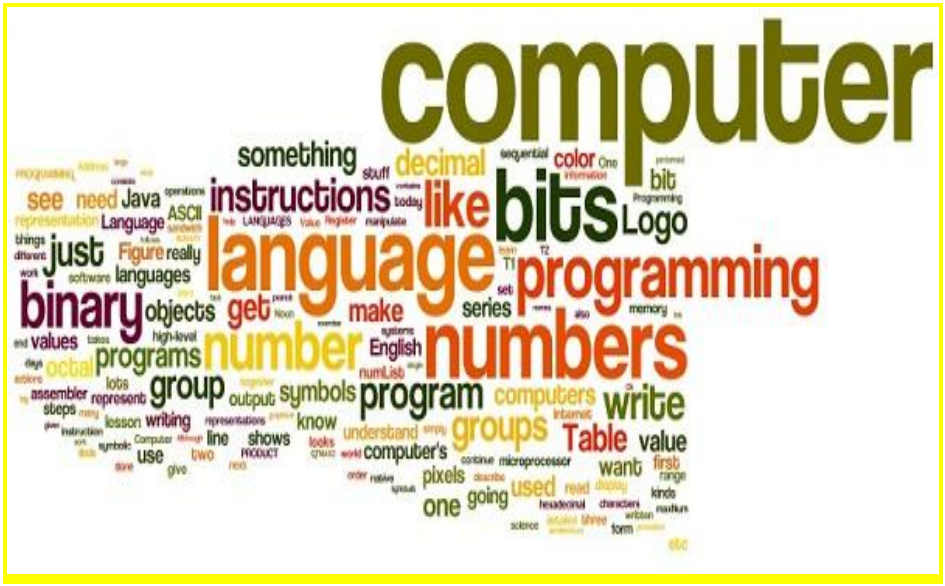
• Sequential Computing is when programs run in order, one command at a time. • Parallel computing is when programs are broken into small pieces, some of which are run simultaneously. • Distributed computing means that a program is run by multiple devices. • Speedup is the time used to complete a task in parallel.	• Explain the existence of undecidable problems • Calculate the speedup of a parallel solution to a problem • Describe the benefits and challenges of parallel and distributed computing. • Explain the difference between sequential, parallel, and distributed computing.
Key Vocabulary: Algorithm, Sequencing, Selection, Iteration, Efficiency, Linear Search, Binary Search, Unreasonable Time, Traveling Salesman Problem, Heuristic, Distributed Algorithm, Parallel Algorithm, Speedup,	
Assessment Evidence	
Performance Tasks: Create Task:**TCC3(9-12), AA1(9-12), and AA2(9-12)** During the task, students will write a program about a topic entirely of their choosing and then write written responses explaining the purpose, functionality, data abstractions, and procedural abstractions they used. They will have at least 12 class hours to complete the task, at the end of which they will submit their work to College Board as part of their AP exam grade.	**Other Evidence:** Unit 9 Quiz - This quiz consists of a series of released problems from AP CS Principles Exams, and requires students to assess what snippets of code do, debug code, or to evaluate different ways of accomplishing the same task. Code.org End of Lesson Checks for Understanding - Part of the code.org curriculum materials include 1-3 questions that summarize learning from the lesson in an open ended format. These questions can easily be shared out by the course instructor to create further discussion. Code.Org Unit 9 Assessment - This end-of-the-unit task assesses student understanding through a variety of multiple choice questions that cover topics from this unit.
Learning Plan	
This unit is a quick exploration of how computer scientists design algorithms to solve problems and how they analyze the speed of different algorithms. Learn about the concept of algorithmic efficiency through a variety of hands-on activities and learn how it's being applied in modern computing. • Algorithms Solve Problems- Students will complete two exploratory activities that introduce the concept of a problem and an algorithm. In the first students answer a series of questions about birthdates and names of their classmates. They then discuss the similarities and	

differences between the problems. In the second activity students are given six different algorithms and must analyze them to determine which they think are the same or different. At the end of the lesson they are introduced to the formal definitions of a problem and an algorithm.**TCC3(9-12)**

- Algorithm Efficiency- In this lesson students follow a demonstration of Linear Search before writing their own search algorithms. Following this, students are introduced to Binary Search after which they compare graphs of the search algorithms to determine which is most efficient. **AA2(9-12)**
- Unreasonable Time- Students investigate two different types of raffles that highlight the way seemingly small problems can quickly grow large. The first raffle asks students to hunt for pairs of tickets that add to a target value. The second raffle asks students to hunt for any group of tickets that adds to a target value. After trying out each raffle live students will try to figure out the patterns for how many total combinations need to be checked in each. At the end they discuss the difference between reasonable and unreasonable algorithms based on their experiences.**AA1(9-12)**
- The Limits of Algorithms- Students explore the limits of what algorithms are able to compute. First they use a widget that exposes students to the Traveling Salesperson Problem. After recognizing this problem can only be solved using an unreasonable time algorithm the develop their own good enough solutions that run more efficiently. Later in the lesson students watch a video about undecidable problems for which no algorithm can ever be developed to solve them.**AA1(9-12)**
- Parallel and Distributed Algorithms- In this lesson students explore the benefits and limitations of parallel and distributed computing. First they discuss the way human problem solving changes when additional people lend a hand. Then they run a series of demonstrations that show how simple tasks like sorting cards get faster when more people help, but there is a limitation to the efficiency gains. Later in the lesson students watch a video about distributed computing that highlights the ways distributed computing can help tackle new kinds of problems. To conclude the lesson students record new vocabulary in their journals and discuss any open questions.**TCC3(9-12)**

Teacher Resources:
Code.org online curriculum; http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

COMPUTER PROGRAMMING (WITH MATHEMATICAL MODELING) CURRICULUM



Grade Level(s): 10-12

Curriculum Author(s): Raymond Robillard

Course Description: Computer Programming (with Mathematical Modeling) is a semester-long course that offers an introduction to the theory and practice of developing computer programs with an emphasis on techniques of program development steeped in object-oriented thinking. Many of the programs will be geared toward mathematical processes, and thus, this course will include a heavy math component. Students will explore topics such as control structures, input/output, loops, objects, classes, simple data structures, and basic concepts of software development. The programming language used in the course is JAVA.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Introduction to Number Systems	• Are there other ways to count and represent numbers?	• Value can be represented in a limitless number of ways, each based on a unique base number system, but the most commonly used in Computer Science are binary, octal, decimal, and hexadecimal.	TCC1(9-12), TCC3(9-12), AA1(9-12)
Working with Types of Data	• How is information input to, stored in, and output by a computing device?	• Information is input to a computing device, abstracted to a binary representation, and then output back in its original form.	TCC3(9-12), TCC4(9-12), TI3(9-12)
Branches and Loops	• How does a computer program use selection and iteration to manage code complexity?	• Control structures, such as conditional statements and loops are abstractions that enable increased complexity to computer programs	TCC4(9-12), TI3(9-12), P4(9-12)
Advanced Programming Techniques	• How do programming languages change and evolve over time?	• Common procedures, notations, and structures have been simplified and improved to meet the needs of Java programmers.	TCC3(9-12), AA1(9-12), AA4(9-12)
Arrays	• How do arrays, and other collection objects, manage code complexity?	• An Array is a data collection tool that allows for organization of real world lists such as rosters, statistics, testing results, etc. using indexes and a series of common searching and sorting algorithms.	CCE2(9-12),. TI3(9-12), P4(9-12)

Unit 1 - Introduction to Number Systems

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
1A-AP-09 - Model the way programs store and manipulate data by using numbers or other symbols to represent information.
1B-AP-08 - Compare and refine multiple algorithms for the same task and determine which is the most appropriate.
2-DA-07 - Represent data using multiple encoding schemes.
3A-CS-01 - Explain how abstractions hide the underlying implementation details of computing systems embedded in everyday objects.
3A-DA-09 - Translate between different bit representations of real-world phenomena, such as characters, numbers, and images.
3B-CS-02 - Illustrate ways computing systems implement logic, input, and output through hardware components.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.

Understandings: Students will understand that...
- Value can be represented in a limitless number of ways, each based on a unique base number system, but the most commonly used in Computer Science are binary, octal, decimal, and hexadecimal.
- A place value represents a quantity of some power of the specified base.
- Language and Images can be abstracted down to 0's and 1's.

Essential Questions:
- Are there other ways to count and represent numbers?
- How do place value and numerical symbols represent value?
- Why do computers use a binary rather than a decimal number system?

Students will know…
- The place values of binary, octal, decimal, and hexadecimal number systems are powers of 2, 8, 10, and 16 respectively.
- The letters "A" through "F" represent digits in a hexadecimal system.
- The smallest base that a number could possibly be in is one more than the largest individual digit.

Students will be able to...
- Convert between any two base number systems.
- Approximate decimal values with negative powers of an indicated base.
- Translate characters and colors between binary and ASCII values of RGB values.

• Characters of text are represented in binary using the Ascii system. • Pixels of an image are represented using the RGB color model	

Key Vocabulary: Number System, Binary, Octal, Decimal, Hexadecimal, Place Value, Base, Power, ASCII, Character, Pixel, RGB

Assessment Evidence

Performance Tasks: **Summative Unit Assessment TCC1(9-12), TCC3(9-12), and AA1(9-12)** Topics will include: • Converting numbers from decimal to binary, octal, and hexadecimal. • Converting numbers from binary, octal, and hexadecimal to decimal. • Explaining how text is represented in binary form • Explaining how color is represented in binary form	**Other Evidence:** Classwork tasks described below • Base Conversion Worksheet • Text Conversion Worksheet Quiz on converting between various number systems

Learning Plan

In its most primitive form, all communication began at a binary level. Yes/No, On/Off, Black/White, etc. are all abstractions of more complex concepts. But, because a computer behaves strictly on the presence, or lack of, electric impulses, they must reduce all information to this binary system. In this unit, students learn how all data can be represented in a binary form, and how we can translate back and forth between these and other forms.

- Binary Learning Activity- Students will be asked to consider a world in which we don't have fingers, but merely stubs on each arm. In this hypothetical world, we can't learn to count in the same way as we haven using our fingers. How does this change things? Students will come to see that regrouping after counting to 2 is the new norm, rather than counting to 10. And in this world, we may have only devised symbols to represent two digits, 0 and 1. This class-long activity includes discussion that focuses on place value, symbolic representation with digits, and other possible base systems(octal and hexadecimal) that would arise in a society of people that have 8 or 16 total fingers. **TCC1(9-12)**
- Base Conversion Worksheet- Students will practice their learning through practice problems that require them to convert between various bases.**AA1(9-12)**
- Text Conversion Activity- Students will be provided a copy of an ASCII conversion chart (https://www.asciitable.com/) and research the origins and the history of the system. Students will discuss implications for ASCII given the numerous languages throughout the world, including some that use different characters in their alphabet, and how these differences in language could be addressed.**TCC3(9-12)**
- Text Conversion Worksheet- Students will be tasked with converting back and forth between written text and ASCII code.**AA1(9-12)**
- RGB Conversion Activity- Students will have an opportunity to explore the way graphics programs, such as Microsoft Paint, use three numbers from 0 to 255 in order to create 16,777,216 unique colors for pixels on a computer screen with the RGB color system. Discussion points will include the math behind how many more colors could be available for every added bit of memory that may be

assigned to a color in an even more advanced system.**TCC3(9-12)**
Teacher Resources: http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 2 - Working with Types of Data

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
2-DA-07 - Represent data using multiple encoding schemes.
2-AP-11 - Create clearly named variables that represent different data types and perform operations on their values.
2-AP-19 - Document programs in order to make them easier to follow, test, and debug.
3A-DA-10 - Evaluate the tradeoffs in how data elements are organized and where data is stored.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
TI3(9-12): I can formulate and investigate probing questions to further my learning.

Understandings: Students will understand that…
- Information is input to a computing device, abstracted to a binary representation, and then output back in its original form.
- Data is either a primitive data type or an object.
- Values stored in variables are not static. They may change over the course of the running of a computer program.
- Programs are made to interact with a user through the process of input and output.

Essential Questions:
- How is information input to, stored in, and output by a computing device?
- What rules/limitations exist for data storage?
- How do we change stored data?
- How do computer programs interact with a user?

Students will know…
- The capacity limitations for the primitive data types.
- The rules for variable names.
- Computer code utilizes the same order of operations that we learn in mathematics
- The remainder operator performs a division, but outputs the resulting remainder, not quotient.
- Distinct Scanner objects should be created for handling

Students will be able to...
- Write a program that declares variables and assigns values to them.
- Write a program that uses arithmetic operators to change the value stored in a variable.
- Write a program that uses input and output in a meaningful way.

input of different variable types	

Key Vocabulary: Primitive Data Type, Object, Bit, Byte, Short, Long, Int, Double, Float, Char, Moore's Law, Variable, Declaration of a variable, Initialization of a variable, Arithmetic Operator, Remainder Operator (%), Unary Minus/Plus, Input, Output, Scanner Object

Assessment Evidence

Performance Tasks:

Summative Unit Assessment TCC3(9-12), TCC4(9-12), and TI3(9-12) Topics will include:

- Comparing and contrasting the uses of 8 primitive data types.
- Explaining how decimal values are represented in binary and how this leads to round off error.
- Identifying variable names that are, or are not, java-appropriate.
- Determining the output of a simple program using various arithmetic operators.
- Identifying proper uses of input and output in a simple program.

Other Evidence:

Classwork tasks described below

- Money Converter Program
- Input and Output Activity

Online Self-Assessment Quizzes and Review Tasks:

- Primitive Data https://chortle.ccsu.edu/java5/Notes/chap08/chap08quizRev2.html
- Variables and Assignment https://chortle.ccsu.edu/java5/Notes/chap09A/chap09quizRev2.html
- Expressions and Arithmetic Operators https://chortle.ccsu.edu/java5/Notes/chap09B/chap09BquizRev2.html
- Input and Output https://chortle.ccsu.edu/java5/Notes/chap10/fillBlankCh10.html

Learning Plan

In object-oriented programming languages like Java, data is categorized into one of two different categories: primitive data types and objects. Students are asked to consider primitive data types as the basic building blocks (the nuts and bolts, wood, steel, cement, etc.) of a programming language and objects as the things we create with those basic building blocks. In this unit, students learn about these primitive data types, operators that are used with data, and the use of input and output to obtain, modify, and produce results with this data.

- Primitive Data Types Introduction- Students are introduced to the 8 primitive data types of Java: bit, byte, short, long, int, double, float, and char. The data capacity for each will be displayed and students should discuss the relative tradeoff of using a variable type with more capacity versus less. Part of this discussion will involve Moore's law, and how the need to minimize capacity has changed over time. Additionally, students will explore how double type numbers are stored in binary and the possibility for round-off errors when doing

so.**TCC3(9-12)**

- Variables and Assignment Lesson- Students will learn how to declare a variable, rules for creating variable names, and how to assign a value to a variable. A focus will be on the difference between declaring a variable versus initializing it.**TCC3(9-12)**
- Expressions and Arithmetic Operators Activity- Students will write an elementary program that changes values stored in variables through the use of Arithmetic Operators. Although students are already familiar with many of these, as well as the order of operations, the inclusion of the remainder operator(%) and the need to differentiate between the subtraction and unary minus operators will be new information.**TCC3(9-12)**
- Money Converter Program- Students will write a program using the remainder operator to take a hard-coded number of pennies and report out how many dollars, quarters, dimes, nickels, and pennies this would be most efficiently converted to.**TCC4(9-12)**
- Input and Output Activity- For the first time, students will write a program that will be interactive. After learning about how a Scanner object works, students will create a program that given four user-entered values, will find the slope of the line that contains two ordered pairs.**TCC4(9-12)**

Teacher Resources: http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 3 - Branches and Loops

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
2-AP-10 - Use flowcharts and/or pseudocode to address complex problems as algorithms.
3B-AP-13 - Illustrate the flow of execution of a recursive algorithm.
3B-AP-21 - Develop and use a series of test cases to verify that a program performs according to its design specifications.
3B-AP-22 - Modify an existing program to add additional functionality and discuss intended and unintended implications (e.g., breaking other functionality).
3B-AP-23 - Evaluate key qualities of a program through a process such as a code review.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
TI3(9-12): I can formulate and investigate probing questions to further my learning.
P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.

Understandings: Students will understand that…
- Control structures, such as conditional statements and loops are abstractions that enable increased complexity to computer programs
- Like tools, different control structures serve different purposes.

Essential Questions:
- How does a computer program use selection and iteration to manage code complexity?
- How does a computer program "make a decision"?
- Why are conditional statements and loops necessary?
- In what ways can loops reduce "code clutter"?

Students will know…
- An if statement can include any number of branched else or else-if statements.
- The behavior of a program depends on the results of conditional statements.
- There are three different types of loops, each with a different structure and purpose.
- A loop allows us to repeat an algorithm a fixed, or variable,

Students will be able to...
- Write programs that incorporate conditional statements in a meaningful way.
- Write programs that incorporate loops in a meaningful way.

number of times.	

Key Vocabulary: If statement, If-else statement, Nested If statement, Loop, While Loop, Counting Loop, Sentinel-controlled Loop, Result-oriented Loop, Nested Loop

Assessment Evidence

Performance Tasks:

Summative Unit Assessment TCC4(9-12), TI3(9-12), and P4(9-12) Topics will include:

- Correcting a program that does not work in order to make it function as intended.
- Identifying the three key components of any loop.
- Comparing and contrasting the types of loops, and what they are used for.
- Writing a program that calculates the third length of a side of a right triangle. The program will use a conditional statement to determine if the program is finding the length of a leg or hypotenuse and a loop to be used for multiple triangles.

Other Evidence:

Classwork tasks described below

- Check Digit Program
- Improved Program with Loop

Online Self-Assessment Quizzes and Review Tasks:

- If Statements https://chortle.ccsu.edu/java5/Notes/chap12/chap12quizRev2.html
- Counting Loops https://chortle.ccsu.edu/java5/Notes/chap16/chap16quizRev2.html
- Sentinel-Controlled Loops https://chortle.ccsu.edu/java5/Notes/chap18/fillBlankCh18.html
- Result-Controlled Loops https://chortle.ccsu.edu/java5/Notes/chap19/chap19quizRev2.html
- Nesting Loops and If statements https://chortle.ccsu.edu/java5/Notes/chap17/fillBlankCh17.html

Learning Plan

In this unit, students will be introduced to the core CS components of selection and iteration. Selection, in terms of computing, refers to a conditional statement that dictates which of two or more possible paths will be followed. The most common structure for this is the “if-then” statement. Iteration is the process of repeating a behavior, often with a change to a condition that dictates the nature and number of repetitions. These two control structures drastically expand a student’s ability to create dynamic, robust programs.

- Flowchart Activity- To introduce the concept of conditional statements and loops, students will build flowcharts that model some real world activity. An example can be seen here: https://europe1.discourse-cdn.com/arduino/optimized/4X/c/2/4/c24af5e1f6386d5c03513d747c86a7cebca870f0_2_327x500.png.**TI3(9-12)**
- If statements discussion- Students will be introduced to, and see in the context of code, the various types of conditional statements.

These include: if-then, if-else, and nested if statements. Discussion will be had about which statements are best in different scenarios and why one type would be chosen over another. Emphasis will be placed on focusing on the number of possible outcomes as it relates to the structure of the conditional statements.**TI3(9-12)**

- Check Digit Program- Students will write code that takes an input of an ISBN Number(Semester Course) or a Credit Card Number(AP) and uses the check digit scheme to determine if the inputted number is legitimate. If it is not, the program should state what the correct check digit should be.**TCC4(9-12)**
- Loop discussion- Students will learn about the three types of loops (sentinel-controlled, result-controlled, counting) and the three key components to each (initialized control variable, condition lined to control variable, way to change this variable). Students will discuss when each type is appropriate.**TI3(9-12)**
- Improved Program with Loop- Students will take any previously written code segment and include a loop that, based on user input, repeats the algorithm until the user indicates otherwise.**P4(9-12)**

Teacher Resources: http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 4 - Advanced Programming Techniques

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3B-AP-11 - Evaluate algorithms in terms of their efficiency, correctness, and clarity.
3B-AP-21 - Develop and use a series of test cases to verify that a program performs according to its design specifications.
3B-AP-22 - Modify an existing program to add additional functionality and discuss intended and unintended implications (e.g., breaking other functionality).
3B-AP-23 - Evaluate key qualities of a program through a process such as a code review.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
AA1(9-12): I can evaluate different approaches and justify the best pathway to success.
AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.

Understandings: Students will understand that…
- Common procedures, notations, and structures have been simplified and improved to meet the needs of Java programmers.
- Boolean expressions are only equivalent only if they are equivalent for all combinations of values for the individual variables.
- For loops are typically the most efficient structure of a loop.

Essential Questions:
- How do programming languages change and evolve over time?
- Are there better ways to do what I already know how to do?
- How can we evaluate complex boolean expressions?

Students will know...
- Some shortcut operators perform a function before or after other sections of code are executed.
- Short-circuit evaluation allows programs to only check a later part of a boolean expression if needed, thus negating the possibility of a potential run-time error.
- A truth table allows us to verify the equivalence of boolean expressions.
- According to DeMorgan's Laws, !(A && B) == !A || !B and !(A || B) == !A && !B.

Students will be able to...
- Use Increment, Decrement, and Assignment Operators in program code.
- Complete a truth table.
- Identify equivalent boolean expressions.
- Use for loops in situations that require a loop.

• A for loop puts all three key components of a loop into one line of code.	

Key Vocabulary: Increment Operators, Decrement Operators, Assignment Operators, “not” (!) Operator, “and” (&&) Operator, and “or” (||) Operator, Short-circuit Evaluation, Truth Table, DeMorgan’s Laws, For Statement

Assessment Evidence

Performance Tasks:

Summative Unit Assessment TCC3(9-12), AA1(9-12), and AA4(9-12)
Topics will include:

- Identifying the correct result of using increment, decrement, and assignment operators.
- Completing missing columns in a truth table.
- Matching equivalent boolean expressions based on their truth values.
- Explaining, and demonstrating with an example, the purpose of using short-circuit evaluation
- Rewriting a code segment with a standard loop to contain a for loop, while retaining all functionality.

Other Evidence:

Classwork tasks described below

- Guess Who Activity
- Caesar Cypher Program

Online Self-Assessment Quizzes and Review Tasks:

- Increment, Decrement, and Assignment Operators https://chortle.ccsu.edu/java5/Notes/chap39/chap39quizRev2.html
- Boolean Expressions and Short-circuit Operators https://chortle.ccsu.edu/java5/Notes/chap40/chap40quiz.html
- Truth Tables and DeMorgan’s Laws https://chortle.ccsu.edu/java5/Notes/chap40B/fillBlankCh40B.html
- The For Statement https://chortle.ccsu.edu/java5/Notes/chap42/chap42quizRev2.html

Learning Plan

This unit builds on previous topics in ways that are either covered in more depth, or by introducing upgraded approaches to foundational concepts already learned. Increment, Decrement, and Assignment Operators allow alternate ways to change the values stored in variables. Handling of conditional statements is approached much more deeply through the analysis of truth tables, by the creation of complex boolean statements, and the use of DeMorgan’s Laws to simplify these statements. The For loop takes the three key components of a loop and combines them into a single statement, thus creating code that is easier to troubleshoot and debug.

- Shortcut operator activity- Students will read the following information https://chortle.ccsu.edu/java5/Notes/chap39/ch39_1.html and do a think-pair-share activity on what they have learned.**TCC3(9-12)**

- Truth Table Demonstration- Students will be shown the basic truth tables for a “not” (!), “and” (&&), and “or” (||) operator. Increasingly difficult truth tables will be worked on by students in small groups. Through the use of truth tables, DeMorgan’s Laws will be demonstrated and proven.**AA4(9-12)**
- Guess Who Activity- Students will write a program that, given the least number of pieces of information, stored as boolean variables, will uniquely identify each member of the class.**AA1(9-12)**
- For Loop Discussion- Students will be shown a program that uses a for loop alongside a program that uses a standard loop, but both programs do the exact same thing. Students should highlight the three key components of the standard loop and, with the same color highlighter, indicate where those components show up in the for loop.**TCC3(9-12)**
- Caesar Cypher Program- Students will write a Caesar Cypher program. This program would take in a user input of text as well as a number(x) for the displacement of the letters in the alphabet. The program will use a for loop to iterate through the indexes of the string and change the text by swapping out letters for the ones x spaces over in the alphabet. For example, if x was 3, a->d, b->e, c->f, and so on. The program should then report what the coded message would be.**AA1(9-12)**

Teacher Resources: http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

Unit 5 - Arrays

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:
3A-AP-14 - Use lists to simplify solutions, generalizing computational problems instead of repeatedly using simple variables.
3B-AP-12 - Compare and contrast fundamental data structures and their uses.
3B-AP-21 - Develop and use a series of test cases to verify that a program performs according to its design specifications.
3B-AP-22 - Modify an existing program to add additional functionality and discuss intended and unintended implications (e.g., breaking other functionality).
3B-AP-23 - Evaluate key qualities of a program through a process such as a code review.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
TI3(9-12): I can formulate and investigate probing questions to further my learning.
P4(9-12): I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging.

Understandings: Students will understand that…

- An Array is a data collection tool that allows for organization of real world lists such as rosters, statistics, testing results, etc. using indexes and a series of common searching and sorting algorithms.
- Variables can be referenced through the name of a collection object and the index of that object more easily than through the use of numerous variable names.

Essential Questions:

- How do arrays, and other collection objects, manage code complexity?
- When is it appropriate to use an array?

Students will know...

- Each cell of a numeric array is initialized to zero; each cell of an array of references is initialized to null.

Students will be able to...

- Initialize, adjust, and read values from an array in a variety of Java programs.
- Construct two dimensional arrays for use in Java programs.

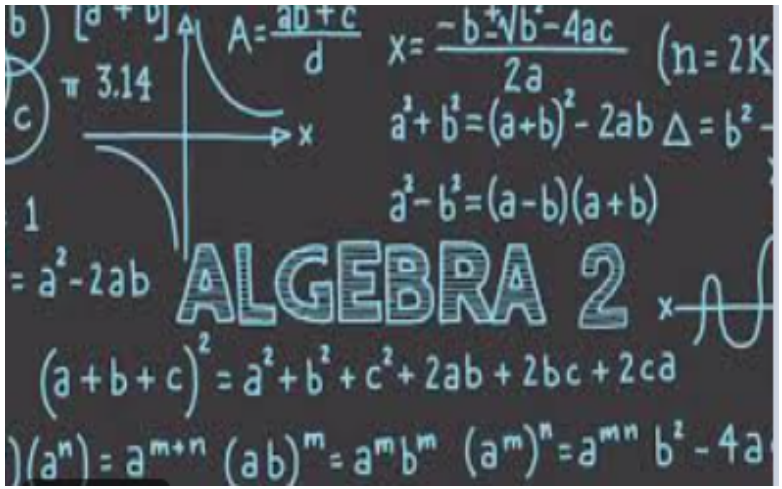
• A statement of the form arrayB=arrayA will only copy the object reference in arrayA to arrayB, it will not change the contents of arrays. • Because an array index starts at 0, but counting loops usually start at 1, there is a high likelihood of error without careful attention to detail. • Arrays can contain string references inside cells. • A 2-d array is a 1-d array of 1-d arrays.	
Key Vocabulary: Array, Index, 1-d Array, 2-d Array, Row-Column Order	
Assessment Evidence	
Performance Tasks: **Summative Unit Assessment CCE2(9-12), TI3(9-12), and P4(9-12)** Topics will include: • Explaining how and when an array should be used. • Determine if notation used to interact with an array is syntax and error free. • Complete a program that finds the average value of the integers stored in an array. • Generate a 2-d array of specific size such that each cell is the product of its indices	**Other Evidence:** Classwork tasks described below • Grade List Program • Seating Chart Activity Online Self-Assessment Quizzes and Review Tasks: • Introduction to Arrays https://chortle.ccsu.edu/java5/Notes/chap46/chap46quizRev2.html • Common Array Algorithms https://chortle.ccsu.edu/java5/Notes/chap47/chap47quizRev2.html • Arrays as Parameters https://chortle.ccsu.edu/java5/Notes/chap48/fillBlankCh48.html • Methods that Change Arrays https://chortle.ccsu.edu/java5/Notes/chap49A/chap49AquizRev2.html • Two-dimensional Arrays https://chortle.ccsu.edu/java5/Notes/chap49C/chap49CquizRev2.html
Learning Plan	

In this unit, students learn the data structure of an array. Arrays allow for the storage of multiple variables without the need for individual variables. In some cases, an array is not only more efficient, but the only way for a program to process a collection of some number of similar variables.

- Array introduction- Students will be shown the basics for creating an array, storing, accessing, and changing values in the array, and an algorithm for iterating through the array with a loop in order to perform some function on the array such as printing out the contents. Students will write their first array program, one that creates a list of random numbers, in groups of 2.**CCE2(9-12)**
- Grade list program- Students will write a program that stores grades in a 1-d array. Scores can be accessed, modified, or deleted based on input from the user. As an extension, students may try to write an algorithm to figure out the average of the grades at any point.**P4(9-12)**
- 2-d array lesson- The concept of a 2-d array is a difficult one for students because Java processes a 2-d array as a 1-d array of 1-d arrays. The visualization of this for students takes some time, but is best explained with the real world metaphor of a series of hallways that each contain a series of lockers.**TI3(9-12)**
- Seating chart activity- Students will write a program that makes a seating chart as a 2-d array. User input allows strings of names to be input into various spots in the chart and then the resulting seating chart is printed out.**P4(9-12)**

Teacher Resources: http://chortle.ccsu.edu/Java5/index.html#07; Java Runtime Environment; Java Development Kit

ALGEBRA 2 CURRICULUM



Grade Level(s): 10-12

Curriculum Author(s): Shannon Belanger, Laurenn Bertoglio, Jamie Lisevick, Kristen Pisano, and Raymond Robillard

Course Description: Algebra 2 is the study of functions. Throughout the course of the year, students will perform operations with functions and study their behavior. Students will think critically to analyze graphs and model real-world applications to solve problems. This course includes the following topics:

- Functions: Relationships between inputs and outputs
- Systems and Linear Programming
- Quadratic equations: Factoring, graphing, and solving
- Polynomials: Operations, graphing, and proving identities
- Rational functions: Graphing functions with vertical or horizontal asymptotes
- Exponential and logarithmic functions: Understanding and solving equations while applying them to other topics
- Radicals: Simplifying and solving equations
- Statistics: Two-way frequency tables, sampling, and probability

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Introduction to Functions	What is a relation and what characteristics make that relation a function?	Functions can be transformed through operations such as translations, reflections, dilations, and compositions, which affect their graphs in predictable ways.	TCC1(9-12); CCE2(9-12); CCE4(9-12); DE4(9-12)
Systems of Linear Functions and Inequalities	In what ways is a system of equations and/or inequalities be used to model and solve real-world problems?	A system of linear equations is an algebraic way to compare two equations that model a situation, find the breakeven point or choose the most efficient or economical plan.	TCC2(9-12); CCE1(9-12); DE1(9-12)' AA1(9-12)
Quadratic Functions	How do the different forms of quadratic equations (standard, vertex, and factored) provide insights into the properties of the quadratic function?	Quadratic functions can be used to model real world relationships, such as projectile motion, area problems, and optimization scenarios. The key features in quadratic functions have meaning in real-world contexts.	TCC1(9-12); P1(9-12); P4(9-12)
Polynomial Functions	What are the defining characteristics of polynomial functions and how do their degrees and coefficients affect their behavior?	Polynomial functions are expressions consisting of variables and coefficients, involving only non-negative integer powers of the variables.	TCC3(9-12); P2(9-12); P3(9-12); TI3(9-12)
Rational Functions	What is an asymptote and where does it occur in the graph of a rational function?	Rational functions have asymptotic behavior, which creates restrictions for both the domain and range.	TCC3(9-12); CCE1(9-12); P2(9-12); P3(9-12); TI3(9-12)

Radical Functions	What are the defining characteristics of radical functions and how do they differ from other types of functions?	Radical functions, which include expressions with roots such as square roots and cube roots, have unique properties and behaviors that differentiate them from polynomial and rational functions.	TCC1(9-12), TCC3(9-12), CCE2(9-12), TI3(9-12), AA1(9-12)
Exponential and Logarithmic Functions	How are exponential and logarithmic functions used to model real-world phenomena?	Exponential functions model situations involving growth or decay, such as population growth, radioactive decay, and interest calculations, while logarithmic functions are used to model phenomena like the Richter scale for earthquakes and pH in chemistry.	TCC4(9-12); CCE3(9-12); AA1(9-12); TI3(9-12)
Properties and Attributes of Functions	In what ways can understanding the property and attributes of functions enhance our ability to model and solve real-world problems?	The properties of functions and function operations are used to model, analyze, and predict real-world phenomena.	TCC3(9-12); AA4(9-12); CCE4(9-12); TI2(9-12)
Statistics	How can we determine information about a population when it is impossible, or impractical, to measure the entire population?	Evaluating data involves understanding methodologies, recognizing biases, and assessing the validity and reliability of the conclusions.	TCC2(9-12); TI3(9-12)

Unit 1 - Introduction to Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **F.IF.A.1** Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
- **F.IF.A.2** Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
- **F.IF.B.4** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* ★
- **F.IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
    - **F.IF.C.7.A** Graph linear and quadratic functions and show intercepts, maxima, and minima.*
    - **F.IF.C.7.B** Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*
- **F.IF.C.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.
- **F.BF.A.1** Write a function that describes a relationship between two quantities.*
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

- **F.LE.A.2** Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
- **S.ID.B.6.A** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
- **S.ID.B.6.C** Fit a linear function for a scatter plot that suggests a linear association.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- I can ask purposeful, insightful questions to find a variety of innovative solutions. **TCC1(9-12)**
- I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success. **CCE2(9-12)**
- I can communicate and express my understanding in an authentic, respectful, and relevant way, using the most efficient mode of expression. **CCE4(9-12)**
- I can work respectfully with all members of my community and support the needs of others **DE4(9-12)**

Understandings: Students will understand that...

- Relations and functions can be represented numerically, graphically, algebraically, and/or verbally.
- Functions are essential models for describing relationships between quantities in mathematics and the real world.
- There are sets of functions, called families, in which each function is a transformation of a special function, called the parent function.
- Functions can be transformed through operations such as translations, reflections, dilations, and compositions, which affect their graphs in predictable ways.
- Graphical representations of functions can provide additional insight into a function's behavior.

Essential Questions:

- What is a relation and what characteristics make that relation a function?
- How are algebraic, numeric, and graphical representations of functions related?
- What is domain and range and how is the domain and range of a function determined by the graph?
- How does the transformation of the function impact the graph and its domain and range?
- How do the critical features of a function's graph, such as intercepts and asymptotes, inform us about the function's behavior?

Students will know...

- A function is a specific type of relation in which each element in the domain is paired with a unique element of the range. Any situation that has a constant rate of change can be represented with a linear function.
- The terms domain, input and independent can be used interchangeably. The terms range, output and dependent variable can be used interchangeably. An independent variable is the controlling factor of the function. The dependent variable changes based on the value of the independent variable.
- A linear function is the graph of a line, while the absolute value function is the graph of two symmetrical linear branches that meet at a common point (vertex).
- A transformation is a mathematical operation performed on a parent function which changes a graph's size, shape, orientation or position.
- Connect slope to the vertical stretch/compression and/or reflection and the y-intercept to the translation up/down.
- Determining an output value for a particular input involves evaluating an expression.

Students will be able to...

- Determine if a relation is a function.
- Find the input of a function given the output and vice versa.
- Identify the domain and range of a function.
- Write equations of linear functions and identify their transformation.
- Sketch the parent function graph of each type of function (linear, absolute value, quadratic) under transformations discussed in the unit.
- Identify transformations on each function type of parent function discussed within the unit.
- Graph simple piecewise function. ★

Key Vocabulary:

Function
Input/Independent Variable
Output/Dependent Variable
Domain
Range
Interval Notation
Relation
Vertical Line Test

Continuous ★
Discrete ★
Absolute Value Function
Quadratic Function
Parabola
Square Root Function
Vertical Shift/Translation
Horizontal Shift/Translation

Vertical Stretch
Vertical Compression/shrink

Reflection over x-axis
Piecewise Function ★
Step Function ★

Assessment Evidence	
Performance Tasks: **Summative Unit Assessment CCE4(9-12)** Topics will include: ● Identify the transformation from a graph or equation. ● Write the equation of a transformed function using the verbal description. ● Graphing functions using their transformation. ● Identify the domain and range of the given function from a graph. ● Write a linear model. ● Evaluate and graph piecewise functions. ★	**Other Evidence:** **Activity**: **Famous Ages** This introductory activity will provide opportunities for students to guess the ages of various famous celebrities. Conversation about who is the better guesser, focused on different mathematical analysis will follow. Then students will begin to model this data using the graphing calculator to become familiar with its features. This activity helps to build a positive culture in the classroom environment by setting the tone that we are going to do difficult things in this room, and we can all persevere and be successful. It also helps to establish that mistakes are expected and respected. **DE4(9-12); TCC1(9-12)** **Interim:** ● Quiz on Functions (including domain and range) and their transformations (graphing and identifying the transformation from an equation) ● Quiz on Piecewise Functions ★ **Common Formative Assessments: CCE2(9-12)** ● Linear Functions (writing equations of lines, identifying the transformation, and graphing) ● Parent Functions

Learning Plan
Algebra 2 is the study of functions. The first unit of this course is designed to formally introduce the idea of what characteristics make a relation a function. Emphasis on beginning to create connections between the parent function, its graph, and the transformation of the function will occur throughout this unit. ● Famous Ages Activity (described above) **DE4(9-12); TCC1(9-12)** ● Transformations of Functions activity - students will use Desmos to investigate the different features of transformations of functions using the slider feature to explore what a, b, h, and k do for the generic function y=a(bx-h)+k. **TCC1(9-12)** ● Practice identifying the transformation of a given function and creating a graph. **CCE2(9-12)** ● Connect the idea of identifying the transformation to linear functions. Discuss how the slope is the vertical stretch/compression and/or reflection across the x-axis; and the y-intercept is the translation up or down. Students will also have the opportunity to review the

prerequisite skill of creating linear equations and graphing. **CCE4(9-12)**
- Piecewise Functions - Evaluate and graph piecewise functions ★

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

Unit 2 - Systems of Linear Functions and Inequalities

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **N.Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
- **N.Q.A.2** Define appropriate quantities for the purpose of descriptive modeling.*
- **N.Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.CED.A.3** Create equations that describe numbers or relationships. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
- **A.REI.C.5** Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
- **A.REI.C.6** Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
- **A.REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **A.REI.D.12** Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.

- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2(9-12)**
- I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, and actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. **CCE1(9-12)**
- I can acknowledge, process, and respond appropriately to others' comments and perspectives. **DE1(9-12)**
- I can evaluate different approaches and justify the best pathway to success. **AA1(9-12)**

Understandings: Students will understand that...

- A system of linear equations is an algebraic way to compare two equations that model a situation, find the breakeven point or choose the most efficient or economical plan.
- Solutions to systems can be interpreted algebraically, geometrically, and in terms of the context of an application.
- The graphical representation of a system provides a visual understanding of solutions, intersections, and the feasible region.
- Optimization is finding the best solution within given constraints.★

Essential Questions:

- In what ways is a system of equations and/or inequalities be used to model and solve real-world problems?
- What are the different methods to solve a system?
- When is it more appropriate to use one method of solving a system over another?
- How does linear programming (modeling) relate to optimizing situations in the real-world? ★

Students will know...

- There are situations that require two or more equations to be satisfied simultaneously.
- There are four methods to solve systems and equations – one graphic and three algebraic. All methods result in the same solution, but one method may be more efficient.
- The intersection of graphs is a solution to the system of equations represented by those graphs.
- Expressions can be substituted for variables.
- Multiplying equations to eliminate a variable creates an equivalent system to the original.

Students will be able to...

- Graph and solve a system of linear equations by graphing.
- Solve a system of linear equations by substitution.
- Solve a system of linear equations by elimination.
- Create and solve a linear system to represent a real world scenario.
- Graph and solve a system of linear inequalities.
- Create and solve a system of linear equations in three
- variables. ★
- Solve a linear programming problem from a set group of constraints and an objective function.★

• When a system has no solutions, its graph contains parallel lines, so there is no intersection point. When solving algebraically, it results in a mathematically untrue statement (i.e. 0 = 4).
• When a system has infinite solutions, the graph contains two or more lines that overlap entirely (same line), resulting in infinite intersection points. When solved algebraically, it results in a mathematically true statement (i.e. 4=4).
• The graph of a linear inequality divides the coordinate plane into two half planes. One side of the boundary line will represent solutions and is shaded to show this.
  ○ ≤,≥ have a solid boundary line
  ○ <.> have a dashed boundary line
• Many real life problems involve a process called optimization which means finding the maximum or minimum value of a specific quantity.
	• Differentiate between 1 solution, no solutions, or infinite solutions on a system of linear equations.

Key Vocabulary:

Linear Equations	Solution	Inequality
Linear	No Solution (Parallel Lines)	Feasible Region ★
Slope	Consistent	Infinitely Many Solutions
Y-intercept	Independant	Linear Programming
X-intercept	Dependent	Constraint ★
Systems of Equations	Inconsistent	Objective Function ★
System of Inequalities		

Assessment Evidence

Performance Tasks: **Summative Unit Assessment: AA1(9-12); TCC3(9-12)** • Solve system of equations using appropriate method (Graphing, Elimination, Substitution) • Create and solve applications of systems of linear equations and inequalities, such as ticket sales. • Graph systems of inequalities and interpret its solution.	**Other Evidence:** **Activity: CCE1(9-12), DE1(9-12)** As we review solving systems of linear equations, students will discuss the most-efficient method for solving. **Interim Assessment: AA1(9-12)** • Solving Systems of equations by graphing, substitution,

• Create and evaluate systems of 3-variable equations given a word problem ★ • Apply learning to solve Linear Programming applications in regards to maximizing and minimizing, such as the Cookie Problem.★	Elimination, and applications. • Solving and applications of 3-variable systems ★ **Common Formative Assessments: TCC3(9-12)** • Graphing and solving systems of inequalities

Learning Plan

Solving linear systems of equations and inequalities reviews critical concepts from Algebra 1 of writing equations of lines and reviewing how to solve in two variables. Connection between the intersection point(s) on graphs and algebraic solving will be extended. Students will discern the best approach for solving based on the form of the given system.

- We will review solving systems graphically and algebraically using substitution and elimination. A Solving Systems 3 ways graphic organizer will help students begin to organize their thinking and reasoning. **AA1(9-12)**
- We will then extend graphing systems of linear equations to linear inequalities to develop an understanding of the feasible region. This will include the Graphing Systems of inequalities zombie activity. **DE1(9-12), CCE1(9-12)**
- In honors, students will extend solving systems from two variables to three variables and solve a 3-variable systems Mathlib. **TCC2(9-12)**
- Finally, linear systems will be applied using linear programming, which involves optimization and utilizing various constraints. Activities will include a linear programming around the room stations activity. **TCC2(9-12), CCE1(9-12), AA1(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets; mini white boards

Unit 3 - Quadratic Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **N.Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
- **N.Q.A.2** Define appropriate quantities for the purpose of descriptive modeling.*
- **DN.Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*
- **N.CN.A.1** Know there is a complex number i such that i^2 = −1, and every complex number has the form a + bi with a and b real.
- **N.CN.A.2** Use the relation i^2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
- **N.CN.A.3 (+)** Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
- **N.CN.C.7** Solve quadratic equations with real coefficients that have complex solutions.
- **N.CN.C.9 (+)** Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.
- **A.SSE.A.2** Use the structure of an expression to identify ways to rewrite it. For example, see x^4 – y^4 as (x^2)^2 – (y^2)^2, thus recognizing it as a difference of squares that can be factored as (x^2 – y^2)(x^2 + y^2).
- **A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
    - **A.SSE.B.3.A** Factor a quadratic expression to reveal the zeros of the function it defines.
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.CED.A.3** Create equations that describe numbers or relationships. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
- **A.REI.B.4** Solve quadratic equations in one variable.
    - **A.REI.B.4.A** Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p)^2 = q that has the same solutions. Derive the quadratic formula from this form.
    - **A.REI.B.4.B** Solve quadratic equations by inspection (e.g., for x^2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.
- **A.REI.C.7** Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x^2 + y^2 = 3.
- **A.REI.D.10** Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often

forming a curve (which could be a line).

- **A.REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
    - **F.IF.C.7.A** Graph linear and quadratic functions and show intercepts, maxima, and minima.*
- **F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
    - **F.IF.C.8.A** Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
- **S.ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    - **S.ID.B.6.A** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
- **G.GPE.A.1** Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- I can ask purposeful, insightful questions to find a variety of innovative solutions.**TCC1(9-12)**
- I can self-reflect and seek feedback to build upon my strengths, apply those strengths to overcome obstacles, and share my strategies with others. **P1(9-12)**
- I can take-on challenges and continuously engage in my own long-term strategies to overcome them to demonstrate through personal experience that failures are more instructive than discouraging. **P4(9-12)**

Understandings: Students will understand that... ● There are three forms of quadratics: standard form, vertex form, and intercept form. Each expression has unique properties that aid in creating the graph and/or solving. All quadratics can be expressed in these three forms. ● The graphical representation of quadratic functions aids in understanding their properties, such as intercepts, maximum or minimum values, and symmetry. ● If the product of two quantities equals zero, at least one of the quantities equals zero ● There are a variety of methods to solve a quadratic equation. ● The discriminant of a quadratic equation provides critical information about the nature and number of its roots, helping in predicting whether solutions are real or complex. ● Complex numbers are numbers of the form *a+bi*, where a and b are real numbers and i = sqrt(-1). ● When solving, complex numbers must be in pairs, called complex conjugates. ● There are various methods of solving a quadratic, each with their own strengths and difficulties depending on the structure of the equation. ● Quadratic functions can be used to model real world relationships, such as projectile motion, area problems, and optimization scenarios. The key features in quadratic functions have meaning in real-world contexts.	**Essential Questions:** ● How do the characteristics of a quadratic equation affect its graphical representation? ● What are the essential characteristics of quadratic functions and how can they be identified from the equation and graph? ● How do transformations affect the graph of a quadratic function, and how can these be represented algebraically? ● How is a linear equation different from a quadratic equation? ● How do the different forms of quadratic equations (standard, vertex, and factored) provide insights into the properties of the quadratic function? ● How does the form of a quadratic determine the way it is graphed and/or solved? ● What are the different methods of solving quadratic equations and when is it appropriate to use each method? ● How do you determine the most efficient method to solve a quadratic? ● What determines the nature (real or complex) of the solutions to a quadratic equation? ● What does the discriminant reveal about the solutions of a quadratic equation, and how can it be used to predict the nature of the roots? ● How are quadratic functions used to model and solve real-world phenomena? ● Why are complex numbers necessary?
Students will know… ● Quadratic functions can be represented graphically, algebraically, or numerically. ● Quadratic equations take on various forms and represent the same graphical picture. ● The quadratic equation represents the graph of a parabola. The characteristics/transformation of a quadratic equation determine the size and direction of the parabola. ● Quadratic functions have an axis of symmetry through the vertex.	**Students will be able to...** ● Graph quadratic functions (both equations and inequalities) in standard, intercept, and vertex form. ● Interpret the key features of the graph and apply to real-world situations. ● Factor quadratic functions/equations to find x-intercepts/ solutions ● Factor using the Greatest Common Factor (GCF), difference of two squares, grouping, a=1, and a>1. ● Factor using sum and difference of cubes★

• The y-value of the vertex is the maximum or minimum of the quadratic function. • The x-intercepts of the graph are the solutions of the equation. • The structure of a quadratic equation or function informs best practices for solving or graphing. We can convert between structures (i.e. standard to intercept form). • Factoring is the inverse of multiplication. • The form of the quadratic equation determines which solution method (factoring, square roots, completing the square, and quadratic formula) is most efficient or appropriate. • The discriminant is used to determine the number and type of solutions to a quadratic equation. • Complex numbers arise when the solution includes the square root of a negative number. • The best method for solving a quadratic equation depends on the original format of the equation. • Using the given information can be substituted into one of the forms of a quadratic equation to create the equation. • Quadratic functions model real-world data that is parabolic in nature. • The general equation that models an object's vertical motion. • Previous knowledge (for example, area is length x width, revenue is product x price, etc.) can be represented by/applied to quadratic equations/functions.	• Solve quadratic equations using square roots, factoring, completing the square, and the quadratic formula. • Defend/justify the most efficient approach to solving a quadratic equation. • Connect the solutions of the equations with the x-intercepts of the function. • Analyze the number and type of solution using the discriminant and/or interpreting the graph. • Create quadratic equations. • Analyze quadratic functions in different forms to find vertex, y-intercept, and solutions. • Perform operations on complex numbers. • Solve vertical motion applications. • Use quadratic reasoning (for example, area is length x width, revenue is product x price, maximum = vertex, etc.) to solve problems. • Use technology to generate a quadratic model fitting a set of data (given or generated).

Key Vocabulary:

Quadratic	Standard Form	Binomial
Quadratic Function	Intercept Form	Quadratic Formula
Parabola	Vertex Form	Discriminant
Axis of symmetry	Solution	Complex Number
Vertex	Zero/Root	Imaginary Number
Maximum	X-intercept	Real Number
Maximum value	Radical	Conjugate
Minimum	Square Rooting	Complex Conjugate
Minimum value	Completing the Square	Center

Assessment Evidence	
Performance Tasks: **Summative Unit Assessment TCC1(9-12)** Topics include: ● Quadratics Test #1: Solving Quadratics by factoring ○ Graphing in all three forms ○ GCF ○ Grouping ○ Trinomial a=1 ○ Trinomial a≠1 ○ Difference of Squares ○ Sum/Difference of Cubes★ ● Quadratics Test #2: Solving all methods **P4(9-12)** ○ Factoring ○ Applications with solving by factoring, ie) area ○ Square root method ○ Completing the square ○ Quadratic formula ○ Using graphing calculator ○ Applications: modeling a falling object and/or a thrown projectile.	**Other Evidence:** **In Class Activity: P1(9-12)** ● Desmos Explore activities ● Google slides activities ● Zombie Factoring flip book ● Escape room reviews ● Around the room scavenger hunt applications ● Guided notes ● Graphic organizer: completing the square **Common Formative Assessments/Interim Assessments:** ● Quiz on Graphing: including the following forms of quadratic ○ Vertex form ○ Standard Form ○ Intercept form ○ Applications: maximum/minimum, area, picture frame, revenue★ ● Quiz on simplify polynomials, factor by GCF, grouping, a=1 and a≠1 with GCF, and difference of Perfect Squares. Solve with a sketch of x-intercept ● Quiz on simplifying radicals, rationalizing denominators, solving by square root property, vertical motion dropping problems ● Quiz on Complex number system: adding, subtracting, multiplying, dividing, simplifying and solving by completing the square. (CP classes might make this 2 separate quizzes) ● Quiz on solving using the quadratic formula and using the discriminant to find number of real solutions

Learning Plan
In this unit, students will explore different strategies for graphing and solving quadratic equations and functions. We will look to connect key features of the graph of the function with the equation in a variety of forms. This structure then helps to inform students of the most efficient method for solving quadratic equations. Additionally, time will be emphasized on learning the skill of factoring. Factoring is a necessary structure for students to learn in order to be able to apply and efficiently solve more challenging problems throughout the remainder of the year.

- Students will learn that the zeros/x-intercepts of the graph are the solutions to the quadratic equation. Students will explore a variety of techniques for solving and compare each to the structure of the given equation to determine the most efficient method for solving. **TCC1(9-12)**
- Students will review the structure of factoring. Factoring helps students to see structure and problem solve more efficiently. We will review a variety of techniques for factoring depending on the structure of the expression.**P1(9-12)**
- Students will learn the three forms of quadratic equations (standard, intercept, and vertex forms). They will explore the graphs of each type of form and make connections between the key features.
- Students will explore projectile motion problems using the vertical motion model. **P4(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

Unit 4 - Polynomial Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **A.SSE.A.1** Interpret expressions that represent a quantity in terms of its context.*
  - **A.SSE.A.1.A** Interpret parts of an expression, such as terms, factors, and coefficients.
- **A.SSE.A.2** Use the structure of an expression to identify ways to rewrite it. For example, see x^4 – y^4 as (x^2)^2 – (y^2)^2, thus recognizing it as a difference of squares that can be factored as (x^2 – y^2)(x^2 + y^2).
- **A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
  - **A.SSE.B.3.A** Factor a quadratic expression to reveal the zeros of the function it defines.
- **A.APR.A.1** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
- **A.APR.B.2** Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).
- **A.APR.B.3** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
  - **F.IF.C.7.C** Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.*
- **F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
  - **F.IF.C.8.A** Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
- **N.CN.C8 (+)** Extend polynomial identities to the complex numbers. For example, rewrite x^2 + 4 as (x + 2i)(x – 2i). ★

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- I can integrate relevant information to produce multiple valid solutions. **TCC3(9-12)**
- I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my abilities to overcome my challenges. **P2(9-12)**
- I can accept constructive feedback and use setbacks to adjust my learning journey in order to reach my goals. **P3(9-12)**
- I can formulate and investigate probing questions to further my learning. **TI3(9-12)**

Understandings: Students will understand that...

- Polynomial functions are expressions consisting of variables and coefficients, involving only non-negative integer powers of the variables.
- Polynomial functions can be classified by their degree, which determines their general shape and the maximum number of roots they can have.
- The degree and leading coefficient determine the end behavior of a polynomial function, which helps in sketching and analyzing graphs.
- The zeros/roots of a polynomial function correspond to the x-intercepts of its graph. The multiplicity of a zero affects the behavior of the graph at that intercept, such as whether it touches or crosses the x-axis.
- Polynomial functions model various real-world phenomena, from projectile motion to economics.

Essential Questions:

- What are the two ways we classify polynomials and why are these important?
- What are the defining characteristics of polynomial functions and how do their degrees and coefficients affect their behavior?
- What is the relevance of the zeros, maximum, and minimum values?
- What makes an accurate sketch of a polynomial function?
- Why do we factor polynomials and how do we decide what is the best method to factor?
- Why are there different methods of finding the zeros of a polynomial and how do we decide which method is appropriate?
- For a polynomial function, how are the factors and roots related?
- How can polynomial functions represent real-life situations?

Students will know…	Students will be able to...
• There are differences between linear, quadratic, and polynomial functions. • Polynomials are classified by the degree and number of terms (Monomial, Binomial, Trinomial, Polynomial, Constant, Linear, Quadratic, Cubic, Quartic, Quintic). • Polynomial expressions should be written using standard form. • Binomial expansion can be used to multiply a binomial by itself. • There are various methods that can be used to factor polynomials. • Factoring polynomial functions is a key technique for finding their roots. Students should be familiar with methods such as grouping, synthetic division, and using the quadratic formula. • Recognize that the sum of two squares cannot be factored under the real numbers. • If (x-a) is a factor of a polynomial, then the polynomial has value 0 when x = a. If “a” is a real number, then the graph of the polynomial has (a, 0) as an x-intercept. • Dividing polynomials can produce the zeros of a function. • Synthetic division is a preferred method of long division of polynomials, but may only be used when the divisor is of the form x $\pm k$. • The Fundamental Theorem of Algebra tells us that the degree of the polynomial indicates the number of solutions of the polynomial. • The Rational Zero Theorem (rational root theorem) helps to find a zero/root of a polynomial. • The remainder theorem, along with synthetic division, provides a handy shortcut for evaluating polynomials. • Key characteristics such as continuity, zeros, multiplicity of zeros, and end behavior are important because they describe the behavior of the outputs. These characteristics can be used to sketch a graph of the polynomial. • Polynomials can represent real-life situations, including simple financial modeling and wooden roller coasters.	• Classify a polynomial based on the degree and number of terms. • Write polynomial expressions in standard form. • Recognize when an expression is not a polynomial. • Add, subtract, multiply polynomial expressions. • Divide polynomial expressions using both long division and synthetic division. • Factor polynomials of the following types: common factors, $ax^2 + bx + c$, difference of two perfect squares, perfect square trinomials, factoring completely, and factoring by grouping. • Extend factoring to the sum and difference of cubes. ★ • Apply the Fundamental Theorem of Algebra to write the simplest polynomial with the given roots. • Solve for all of the zeros of a polynomial function, given one of the zeros. • Use the rational zero theorem to find all the zeros. ★ • Sketch the graph of a polynomial using the end behavior, zeros, multiplicities, and y-intercept. • Solve application problems that involve representing a real life situation with a polynomial function. • Create a model and make predictions for real-world phenomena.

Key Vocabulary:

Degree	Binomial	Multiplicities
Exponent	Trinomial	End Behavior
Polynomial	Standard Form	Long Division
Cubic	Leading coefficient	Synthetic Division
Quartic	Zeros of a polynomial	Prime Factorization
Quintic	Rational Root Theorem	Sum of Two Cubes
Monomial	Remainder Theorem	

Assessment Evidence

Performance Tasks:

Summative Unit Assessment TCC3(9-12) Topics include:

- Add, subtract, and multiply polynomials
- Divide polynomials using both long division and synthetic
- Factor polynomials
- Find all the zeros of a polynomial given one zero
- Find all zeros using the Rational Zero Theorem ★
- Sketch the graph of a polynomial function
- Solve application problems that may include modeling financial scenarios.

Other Evidence:

Interim: P3(9-12)

- Quiz on factoring
- Quiz on finding zeros of polynomials including using synthetic division

Common Formative Assessments: P3(9-12)

- Operations of polynomial functions (adding, subtracting, multiplying, and dividing [synthetic and long division])
- Graphing polynomial functions
- Application problems: modeling volume, open box problem.

Learning Plan

Polynomial functions extend students' knowledge to higher-degree expressions. Students will begin to make connections between odd degree polynomials vs even degree polynomials.

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- Students will investigate to discover that odd degree polynomial functions have the same end behavior, as well as even degree polynomial functions. **TI3(9-12)**
- Students will continue to apply their skills of factoring and extend it to Polynomial Functions. This assists students in being able to then graph, solve, and apply the roots/solutions. **TCC3(9-12); P2(9-12)**
- Students will sketch graphs of polynomial function using its end behavior and by factoring to find its x-intercepts. **P3(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets; mini white boards

Unit 5 - Rational Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **A.APR.D.6** Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.
- **A.APR.D.7** (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.
- **A.CED.A.1** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.REI.A.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
- **A.REI.D.11** Represent and solve equations and inequalities graphically. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
- **F.IF.C.7d** (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.*
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.

- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- I can integrate relevant information to produce multiple valid solutions. **TCC3(9-12)**
- I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias. **CCE1(9-12)**
- I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my abilities to overcome my challenges. **P2(9-12)**
- I can accept constructive feedback and use setbacks to adjust my learning journey in order to reach my goals. **P3(9-12)**
- I can formulate and investigate probing questions to further my learning. **TI3(9-12)**

Understandings: Students will understand that...

- Direct, inverse, and joint variations describe relationships between variables allowing us to analyze how one quantity changes in relation to another and predict and control outcomes in various fields such as physics, economics, biology, and engineering.
- Asymptotes are critical features of the graph and indicate domain and range restrictions.
- If a rational function is in simplified form and the polynomial in the denominator is not a constant, the graph of the rational function features asymptotic behavior.
- The rules for operations with fractions can be extended to rational expressions

Essential Questions:

- How are direct, inverse, and joint variations used in the real-world?
- What is an asymptote and where does it occur in the graph of a rational function?
- What are rational expressions and how do we perform operations on them?
- Why should you factor a rational function before simplifying, graphing, and/or solving?
- Why is it important to find as much information as possible about the graph of a function from its equation?

Students will know...

- A rational function is the ratio of two polynomial functions.
- The operations of rational expressions are similar to numerical operations with fractions. For example, when simplifying, you need to factor out the common part. When adding and subtracting rational expressions, students must find a common denominator.
- Solving rational equations expands our capabilities to solve equations whose domain does not include all real numbers.
- The denominator of a rational expression cannot equal zero.

Students will be able to…

- Simplify rational expressions using variation models.
- Graph the rational function y=1/x using transformations.
- Graph a rational function expressed as a linear/linear.
- Determine the asymptotes of the function.
- Identify the domain and range of the rational function.
- Perform operations (add, subtract, multiply and divide) of rational expressions.
- Perform operations with complex fractions.
- Solve rational equations.
- Check for extraneous solutions when solving a rational

	equation. ● Apply rational equations to real-world applications (if time permits).

Key Vocabulary:

Ratio	Rational Function	Extraneous Solution
Proportion	Reciprocal	Vertical Asymptote
Direct Variation	Least Common Denominator (LCD)	Horizontal Asymptote
Inverse Variation	Least Common Multiple (LCM)	Slant Asymptote ★
Joint Variation	Complex Fraction	Hole ★
Constant of Variation/Proportionality		

Assessment Evidence

Performance Tasks:

Summative Unit Assessment TCC3(9-12) Topics will include:

- Solve direct, inverse, and joint variation application problems (could include inheritance questions, purchasing power, and SAT practice questions).
- Graph rational functions
- Perform operations with rational functions including add, subtract, multiply, divide, and simplify complex fractions.
- Solve rational equations

Other Evidence:

Activity: Stations activity on graphing rational functions. Students will collaborate to match the equation to its characteristics/features of the function and its graph. **CCE1(9-12); P2(9-12)**

Interim: Quiz on variation and graphing rational functions **P3(9-12)**

Common Formative Assessments: P3(9-12)

- Graphing Rational Functions and identifying its features
- Adding and subtracting rational expressions
- Multiplying and dividing rational expressions
- Solving rational equations

Learning Plan

Students begin this unit with extending the properties of exponents to rational exponents. Attention converting between radical and rational exponent forms is emphasized here in preparation for Pre-Calc.

- Simplify expressions using the properties of rational exponents and radicals. Student discourse about when a simplifying problem is “complete” and how the context it is used in may produce a different result. **P2(9-12); CCE1(9-12)**
- Graphing radical functions and using their transformations. Students will examine the similarities and differences between quadratic and

square root functions, as well as cubic vs cube root functions.**P3(9-12)**

- Students will solve radical equations. Radical functions highlight the need for using inverse operations when solving problems, including polynomial functions. Additionally, students will be introduced to the idea of extraneous solutions, which answers that occur while solving that do not satisfy the original domain of the problem. We will apply rational equations to real-world problems to solve in a given context (i.e. work and unified motion problems) **TI3(9-12); TCC3(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets; Visual models and diagrams.

Unit 6 - Radical Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **N.RN.A.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 5^(1/3) to be the cube root of 5 because we want [5^(1/3)]^3 = 5^[(1/3) x 3] to hold, so [5^(1/3)]^3 must equal 5.
- **N.RN.A.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents.
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.CED.A.3** Create equations that describe numbers or relationships. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
- **A.REI.A.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
- **F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- I can ask purposeful, insightful questions to find a variety of innovative solutions. **TCC1(9-12)**

- I can integrate relevant information to produce multiple valid solutions. **TCC3(9-12)**
- I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success. **CCE2(9-12)**
- I can formulate and investigate probing questions to further my learning. **TI3(9-12)**
- I can evaluate different approaches and justify the best pathway to success. **AA1(9-12)**

Understandings: Students will understand that...

- Radical functions, which include expressions with roots such as square roots and cube roots, have unique properties and behaviors that differentiate them from polynomial and rational functions.
- Rational exponents and radicals are different ways of expressing the same quantities.
- Radicals and the Rules of Exponents are used to create meaning for rational exponents.
- Methods for solving radical equations expand our capability to solve equations whose domain does not include all real numbers.

Essential Questions:

- What are the defining characteristics of radical functions and how do they differ from other types of functions?
- What is the meaning of an exponent that is not positive and/or not an integer?
- How can we rewrite radical expressions in simpler ways?
- What is the importance of learning to solve radical equations?
- How do transformations affect the graphs of square root and cube root parent functions? ★

Students will know...

- Radical expressions include square roots, cubic roots, and roots of any other index.
- Radical expressions can be simplified by identifying powers under the radical with the same exponent as the index of the radical.
- Radical expressions can be solved by isolating a radical and taking a power on both sides of the equation equal to the index of the radical.
- When solving a radical equation, we must be mindful of the possibility of extraneous solutions.
- Knowledge of a parent function, and the various ways to transform a function, f(x), is sufficient for graphing any radical function.

Students will be able to...

- Evaluate nth roots and simplify rational exponents.
- Simplify radical expressions.
- Perform function operations and composition (include nth roots and rational exponents).
- Graph square root and cube root functions with transformations.★
- Solve radical equations.

Key Vocabulary:

Rational exponent | Index | Cube Root Function

Radical function N^{th} root	Extraneous Solutions Square Root Function	Restricted Domain ★ Power function

Assessment Evidence

Performance Tasks:	Other Evidence:
Summative Unit Assessment TCC3(9-12) Topics will include: ● Simplify Radical expressions with and without variables. ● Rewrite expressions with rational exponents as radical expressions and vice versa. ● Solve radical equations and identify/check for extraneous solutions. ● Graph radical functions with transformations ★	**Common Formative assignments**: ● Rational Exponents and Simplifying N^{th} Root Radicals ● Simplifying Expressions with Rational Exponents Activity ● Simplifying and Rewriting Radical Expressions Activity ● Solving Radical Equations Practice Problems **TCC1(9-12)** ● Graphing Radical Functions with Transformations Activity ★ **Interim: AA1(9-12)** ● Quiz on Simplifying and rewriting Radical Expressions ● Quiz on Solving Radical Equations

Learning Plan

In this unit, students expand their knowledge of types of functions to include radical functions. Restrictions on the domain, that were seen with rational functions, come into play in this unit as well. Students come to understand that the numerator and denominator of a rational exponent coincide with the power and index of a radical in an equivalent expression.

- Students will practice translating between radicals and rational exponents forms. With this, they will also be practicing simplifying these expressions using the Properties of Exponents. **CCE2(9-12), TI3(9-12),TCC1(9-12), AA1(9-12)**
- Students will apply their prior solving skills with the properties of rational exponents to solve radical equations. Attention to checking for extraneous solutions will be emphasized in this lesson - including some tips as to when extraneous solutions will occur. The graphical representation for the visual of the equation, as a system, will be used to emphasize how extraneous solutions occur. **TI3(9-12), AA1(9-12)**
- Graphing Radical Functions with Transformations Activity - Students will extend their knowledge of transformations by applying them to graph radical functions. ★ **AA1(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

Unit 7 - Exponential and Logarithmic Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **A.SSE.A.1** Interpret expressions that represent a quantity in terms of its context.*
  - **A.SSE.A.1.B** Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)^n as the product of P and a factor not depending on P.
- **A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
  - **A.SSE.B.3.C** Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15^t can be rewritten as [1.15^(1/12)]^(12t) ≈ 1.012^(12t) to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
  - **F.IF.C.7.E** Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*
- **F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
  - **F.IF.C.8.B** Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)^t, y = (0.97)^t, y = (1.01)^(12t), y = (1.2)^(t/10), and classify them as representing exponential growth and decay.
- **F.BF.A.1** Write a function that describes a relationship between two quantities.*
- **F.BF.B.5 (+)** Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
- **F.LE.A.1** Distinguish between situations that can be modeled with linear functions and with exponential functions.
  - **F.LE.A.1.C** Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
- **F.LE.A.2** Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

- **F.LE.A.3** Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
- **F.LE.A.4** For exponential models, express as a logarithm the solution to ab^(ct) = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.
- **F.LE.B.5** Interpret the parameters in a linear or exponential function in terms of a context.
- **S.ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    - **S.ID.B.6.A** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- I can integrate my learning to adapt to experiences in the classroom, career and life. **TCC4(9-12)**
- I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products. **CCE3(9-12)**
- I can evaluate different approaches and justify the best pathway to success. **AA1(9-12)**
- I can formulate and investigate probing questions to further my learning. **TI3(9-12)**

Understandings: Students will understand that…

- Exponential functions model situations which grow or decline at a constant percent rate.
- Graphing exponential functions and logarithmic functions will result in asymptotic behavior. Transformations (shifts, stretches, reflections) will affect the graphs.
- Logarithms can be used to solve exponential functions; and conversely, exponents are used to solve logarithmic equations.
- Logarithms can be used to solve equations for which no other algebraic method exists.

Essential Questions:

- How can exponential functions be used to model growth and decay?
- How do you model a quantity that changes regularly over time by the same percentage?
- What is the purpose of logarithms?
- How are exponential and logarithmic functions related to each other?
- How do the properties of exponents extend to the properties of logarithms?
- How do you graph exponential and logarithmic functions by

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- Exponential functions model situations involving growth or decay, such as population growth, radioactive decay, and interest calculations, while logarithmic functions are used to model phenomena like the Richter scale for earthquakes and pH in chemistry.

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analyzing intercepts and end behavior?
- How are exponential and logarithmic functions used to model real-world phenomena?

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Students will know…

- The graph of exponential growth and decay functions has a horizontal asymptote.
- Exponential functions to model real-world situations, such as student loan interest, car depreciation, and
- The constant *e* is an irrational number that appears in many different areas of mathematics, including continuous interest.
- Expressions can be translated between exponential and logarithmic forms.
- The common log has base 10 and the natural log has base *e*.
- Exponential and logarithmic functions have restrictions on the value of the base *b*. This then influences the range or domain.
- The graph of a logarithmic function has a vertical asymptote.
- Condensing and expanding logarithmic expressions are techniques used when solving.
- Solving exponential and logarithmic equations involves applying properties of exponents and logarithms, such as the power rule, product rule, and change of base formula, to isolate the variable and find solutions.
- Techniques for solving equations involving exponential and logarithmic functions include using properties of logarithms, isolating the exponential or logarithmic expression, and applying logarithms to both sides of the equation.
- The exponential function $y=b^x$ is one-to-one, so its inverse $x=b^y$ is a function. To express “y as a function of x” for the inverse you write y=logb x.
- Logistic growth is a model used when there is an upper limit on the size of a population, called the carrying capacity. ★

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Students will be able to…

- Graph exponential growth and decay functions.
- Identify the asymptote and transformation and solve for the intercepts of the graph.
- Apply transformations with exponential and logarithmic functions to graph
- Interpret graphs of exponential and logarithmic functions.
- Model exponential functions for both growth (e.g. population growth and compound interest).and decay (e.g. depreciation and half-life).
- Use compound interest to discover the number *e*.
- Evaluate logarithms
- Expand and condense logarithms
- Solve exponential and logarithmic equations.
- Solve real-world problems involving the common base *e*.
- Model practical uses of logarithms (e.g., measuring sound intensity, pH scale).
- Create and apply exponential and logarithmic functions to model and make predictions.
- Solve problems using Newton’s Law of Cooling. ★
- Model functions using logistic growth and solve application problems. ★

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<td colspan="2">Key Vocabulary:</td>
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Exponential Growth	Compounded monthly, quarterly, etc.	Logarithmic Regression
Exponential Decay	Asymptote	Common Logarithm
Exponential Function	Base	Natural Logarithm
Exponential Regression	Natural base e	Power Function
Growth Factor	Compounded continuously	Logarithmic Equation
Decay Factor	Logarithm	Extraneous Solution

Assessment Evidence

Performance Tasks:

Summative: Students will research colleges in state and out of state specifically focused on tuition prices over the years. Through the use of graphing calculators they will use the data to create an exponential regression model to make predictions for the future. Students will work collaboratively in small groups and will present their findings to the class. **TCC4(9-12)**, **CCE3(9-12)**

Summative Unit Assessment TCC4(9-12) Topics will include:

- Graphing exponential and logarithmic functions.
- Identifying key features of the graph.
- Simplify logarithms
- Expand and condense logarithmic expressions
- Solve exponential and logarithmic equations.
- Model real-world application.

Other Evidence:

- **Activity - Which will grow faster?** Introduction to exponential growth. If you double a penny every day for 30 days what will happen? **AA1(9-12), TI3(9-12)**
- **Activity - Discovery of the number e:** Students will explore the number e through a discovery based lesson to attempt to see what happens when you increase the compounding interest. They will discuss practical applications of e in various fields like finance, population growth, and physics. **AA1(9-12), TI3(9-12)**
- **Interim:** Graphing exponential functions, comprehension of key features such as growth/decay factor, growth/decay rate, asymptote and transformations.
- **Interim:** Applications involving compound growth/decay including continuously. Simplifying with the number e.
- **Interim:** Evaluating logarithms, comprehension of natural logs, common logs and expanding and condensing. Using logarithms to solve exponential equations, which may have extraneous solutions. **AA1(9-12)**

Learning Plan

In this unit, students will extend their knowledge of exponential functions to model growth and decay in numerous applications. Students will explore how transformations (translations, reflections, stretches and compressions) affect exponential and logarithmic functions. Students will learn and apply the fundamental properties of logarithms including the production, quotient, and power rules. Students will solve complex logarithmic and exponential equations and apply them to real world problems and make predictions.

- Students will model exponential growth and decay models involving applications with simple interest, compound interest, depreciation. As they explore which model grows faster and complete the discovery activity for the number *e*, students will work on collaborating and adjusting to meet their learning needs. **TI3(9-12)** Then students will complete the College Tuition Project (described above) **TCC4(9-12); CCE3(9-12)**
- Students will extend their knowledge of transformations of functions by graphing exponential and logarithmic functions. Discussion around similarities and differences both between these two functions and compared to those previously studied will occur. **CCE3(9-12)**
- Students will evaluate different approaches when solving exponential and logarithmic equations. This may include needing to use the properties of expanding and condensing, as well as utilizing their previous skills for solving and checking for extraneous solutions. **AA1(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

Unit 8 - Properties and Attributes of Functions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **A.CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.CED.A.3** Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
- **F.IF.C.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal description). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*
- **F.BF.A.1** Write a function that describes a relationship between two quantities.*
    - **F.BF.A.1.B** Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*
    - **F.BF.A.1c** (+) Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the weight of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.*
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
- **F.BF.B.4** Find inverse functions.
    - F.BF.B.4.A Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x–1) for x ≠ 1.
    - F.BF.B.4.B (+) Verify by composition that one function is the inverse of another.
    - F.BF.B.4.C (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.
- **F.BF.B.5** (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.

- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- I can integrate relevant information to produce multiple valid solutions. **TCC3(9-12)**
- I can create opportunities to extend my learning by remaining open-minded in any situation. **AA4(9-12)**
- I can communicate and express my understanding in an authentic, respectful and relevant way, using the most efficient mode of expression. **CCE4(9-12)**
- I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge. **TI2(9-12)**

Understandings: Students will understand that...

- Functions can be combined through addition, subtraction, multiplication, division, and composition to create new functions with distinct properties.
- The concept of inverse functions is critical for solving equations and understanding the reversibility of processes.
- All functions have an inverse; however, the domain restrictions are critical when determining if the inverse is a function.
- The properties of functions and function operations are used to model, analyze, and predict real-world phenomena.

Essential Questions:

- How do different types of functions (linear, quadratic, etc) differ in their properties and attributes?
- In what ways can understanding the property and attributes of functions enhance our ability to model and solve real-world problems?
- When is it more appropriate to analyze a function algebraically vs graphically?
- How can combining functions create new functions and what are the implications?
- How do you find the inverse of a function and what is its significance?

Students will know...

- There are multiple representations, most common are equations, tables, and graphs.
- End behavior describes the movement if the graph were to continue to extend beyond the given window.
- Performing operations on functions can restrict the domain of the resulting expression.
- Composition of functions is the process of finding the output of one function and then using it as the input for a second function.

Students will be able to...

- Identify key features of the graph, including its domain, range, asymptotes, intercepts, and transformations.
- Identify the end behavior of the function.
- Graph functions and their inverse.
- Create equations using function operations, including composition.
- Solve for the inverse of a function and identify any domain restrictions.

• Composition of functions is not commutative. • Functions are inverses of each other if and only if their compositions both simplify to x. • Technology and analyzing the correlation coefficient can assist in modeling.	• Verify two given functions are inverses of each other through composition. • Create equations to model real-world phenomena (data) using technology.

Key Vocabulary:

Relation	Composition	Horizontal Line Test
Function	Composition of Functions	Inverse
Representations of Functions	Piecewise Function	Inverse Function
End Behavior	Vertical Line Test	One-to-one

Assessment Evidence

Performance Tasks:

Summative Unit Assessment TCC3(9-12) Topics will include:

- Describe the end behavior of the indicated function
- Perform the indicated operation. State any domain restrictions.
- Identify the composition performed.
- Verify that the two functions are inverses.
- Graph piecewise functions
- Determine if the given graph will have an inverse that is a function.
- Find the inverse of the function. State its domain and range.

Function Family Project CCE4(9-12); TI2(9-12)

- Students will create and present the critical attributes of one of the function families studied throughout the year. Their presentation should include examples of applications of this function to real-world phenomena.

Other Evidence:

Common Formative Assessments AA4(9-12)

- Representations of Functions
- End behavior
- Graphing Piecewise Functions
- Operations with Functions
- Finding the inverse of a function and its domain and range

Learning Plan

Algebra 2 is the study of functions. In this unit, students will summarize their learning regarding all function types discussed throughout the year and their various representations (i.e.: table, graph, equation, verbal description). Similarities and differences between function families will be

emphasized, along with connecting the visual representation of the graph to its end behavior.

- Review the definition of a function and its multiple representations (table, graph, equation, and verbal description) **TCC3(9-12); CCE4(9-12)**
- Discuss similarities and differences for all of the parent functions studied throughout the course of the year and describe their end behavior. This includes modeling with real-world data and data analysis.**TCC3(9-12); CCE4(9-12)**
- Use function notation to perform operations with functions. Attention to domain restrictions when dividing and performing composition of functions (greater emphasis and more challenging questions in honors ★ **AA4(9-12)**
- Solve for the inverse function. **AA4(9-12)**

Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

Unit 9 - Statistics

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards (* indicates a modeling standard; ★ indicates greater emphasis in the Honors sections)

- **S.ID.B.5** Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
- **S.IC.A.1** Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- **S.IC.B.3** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
- **S.IC.B.4** Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
- **S.IC.B.5** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
- **S.IC.B.6** Evaluate reports based on data.

Standards for Mathematical Practice

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions. **TCC2(9-12)**
- I can formulate and investigate probing questions to further my learning. **TI3(9-12)**

Understandings: Students will understand that...	**Essential Questions:**

• Two-way frequency tables are essential tools for displaying data. • Statistical practices allow us to make conclusions. • Care must be taken to generate a sample that is representative of an entire population. • Evaluating data involves understanding methodologies, recognizing biases, and assessing the validity and reliability of the conclusions.	• How can two-way frequency tables and relative frequencies help identify associations and trends in categorical data? • How can we determine information about a population when it is impossible, or impractical, to measure the entire population? • How does knowledge of some attribute affect the likelihood of some other attribute? • Which criteria should be used to critically evaluate the credibility and accuracy of data reports?
Students will know... • A sample can be used to make conclusions about an entire population. • Bias can impact the results of a study or experiment. • A treatment is a deliberate change made to a subject as part of an experiment. • Two way tables organize data from some sample or measured on two different variables.	**Students will be able to...** • Identify potential sources of bias in data collection and reflect on their impact in generalizing from a sample to a population. • Discern between observational studies and experiments. • Determine the likelihood of an event based on the knowledge of drawing a result from a subset of data(conditional probability).

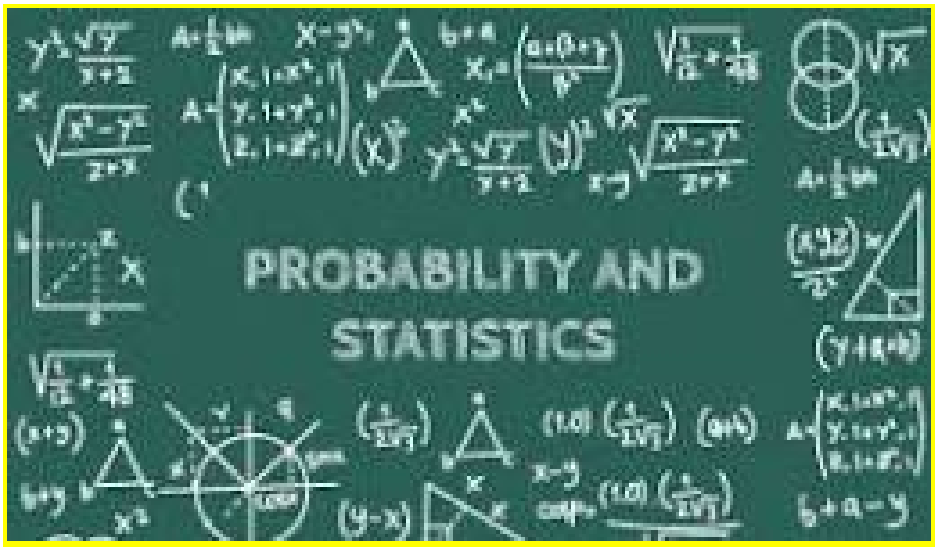
Key Vocabulary:

Sample	Cluster Sample	
Population	Multistage Sample	Treatment
Representative Sample	Bias	Placebo
Sampling Methods	Undercoverage Bias	Control Group
Census	Voluntary Response Bias	Blinding
Convenience Sample,	Response Bias	Two-way table
Simple Random Sample	Non-response Bias	Probability
Systematic Sample	Observational Study	Conditional Probability
Stratified Sample	Experiment	Relative Frequency

Assessment Evidence	
Performance Tasks: **Summative Unit Assessment: TCC2(9-12); TI3(9-12)** topics to	**Other Evidence:** **Common Formative Assessments:**

include: ● Sampling Methods ● Bias ● Observational Studies and Experiments ● Two Way Tables and Conditional Probability	● Sampling Methods, Bias, and Observational Studies and Experiments Quiz (created from SAT released questions) ● Two Way Tables and Conditional Probability (created from SAT released questions)
Learning Plan	
In this unit, students will begin to explore the basics of data collection as part of an observational study or experiment. They will study appropriate ways to collect data, and critique the negative effects that can result when this is not done properly. Students will advance their knowledge of basic probability by considering situations involving conditional probability. These will be visualized primarily through the use of two-way tables where a probability is calculated from one row, or column, of the table. The types of bias can be easily confused by students due to similarities and perceived overlap. Students will learn sampling methods, types of bias, as well as discuss observational strides and experimental design. More important than classifying bias by the correct term is the ability to explain why bias occurred and to speculate on its implications. **TCC2(9-12), TI3(9-12)** For Two Way Tables and Conditional Probability, students will first be introduced to the use of a two-way table, how to fill one in, and the importance of having a row and column for totals. Next, questions of conditional probability will be explored. Students will be encouraged to “block out” information in the table by literally covering up rows or columns based on provided information. **TCC2(9-12)**	
Teacher Resources: Algebra 2 Textbooks; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets	

PROBABILITY AND STATISTICS CURRICULUM



Grade Level(s): 11-12

Curriculum Author(s): Nicole Cowles

Probability & Statistics is a full-year course designed to introduce students to the fields of mathematics which deals with the study of purely chance phenomena (probability) and the science of collecting, organizing, analyzing, and interpreting data(statistics). Through many hands-on activities, students will study topics such as surveying and sampling, the normal distribution, probability theory, confidence intervals and hypothesis testing, and linear regression. There will be a heavy emphasis on problem solving and real world applications.

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Probability (7-8 weeks)	What is probability and how is it used?	A solid understanding of probability enhances one's ability to critically evaluate information, assess risks, and make data-driven decisions.	CCE3(9-12); CCE4(9-12); AA4(9-12)
Univariate Data (8-9 weeks)	Why are some types of graphs and summary statistics more appropriate to display a set of data?	Different types of graphs are appropriate for different types of data and different statistics (measures of central tendency and spread) are appropriate for different sets of data.	CCE4(9-12)
Bivariate Data (4 weeks)	How can linear regression be used to make predictions, and what factors should be considered when making these predictions?	Linear regression is a powerful statistical tool used to model the relationship between two quantitative variables and make predictions based on that relationship.	TCC3(9-12); CCE4(9-12)
Collecting Data (4 weeks)	Why is it important to follow appropriate methods of data collection and how do we design an experiment to ensure that the results are valuable?	Data is a fundamental component in making informed decisions in various fields, from scientific research to business and public policy.	TCC1(9-12); CCE1(9-12); CCE4(9-12)
Central Limit Theorem (2-3 weeks)	What is the Central Limit Theorem and why is it fundamental in statistics?	The Central Limit Theorem (CLT) shows that, regardless of the population distribution, the distribution of the sample means becomes approximately normal as the sample size increases.	TCC1(9-12); TI2(9-12)

Inference Involving Means (5-6 weeks)	How do we use the sample mean to make conclusions about the population mean?	Confidence intervals provide a range of plausible values for a population mean based on sample data, offering a more informative estimate than a single point estimate; significance tests are tools for making informed decisions about population means based on sample data	TCC1(9-12); TCC2(9-12); CCE1(9-12); CCE4(9-12); TI2(9-12); TI3(9-12)
Inference Involving Proportions (3 weeks)	How does inference for data involving proportions differ from inference for data involving means?	Confidence intervals provide a range of plausible values for a population proportion based on sample data, offering a more informative estimate than a single point estimate; significance tests are tools for making informed decisions about population proportions based on sample data.	TCC1(9-12); TCC3(9-12); CCE3(9-12); TI3(9-12)

Unit 1 - Probability

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:
S.ID.B.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
S.CP.A.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").
S.CP.A.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
S.CP.A.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
S.CP.A.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.
S.CP.A.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.
S.CP.B.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.
S.CP.B.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.
S.CP.B.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems.
S.MD.B6 (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
S.MD.B7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
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- **MP4:** Model with mathematics.

- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
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Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.
CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.
AA4(9-12): I can create opportunities to extend my learning by remaining open-minded in any situation.

Understandings: Students will understand that…

- Probability is a mathematical framework for quantifying uncertainty and making informed predictions about future events.
- Theoretical probability provides a model for predicting the likelihood of events, while experimental probability is derived from actual data and observations.
- The fundamental rules of probability, including the addition and multiplication rules, govern the likelihood of single and compound events.
- Understanding the concepts of independence and dependence is critical for correctly applying probability rules to different scenarios.
- A solid understanding of probability enhances one's ability to critically evaluate information, assess risks, and make data-driven decisions.

Essential Questions:

- What is probability and how is it used?
- Why is it important to understand the difference between theoretical and experimental probability?
- How does probability theory relate to decision-making in uncertain situations?
- What is the difference between a permutation and a combination?
- How do odds differ from probability?
- How is determining a conditional probability different from determining a simple probability?
- What are the key differences between independent and dependent events in probability?

Students will know...	Students will be able to...
• A simple probability of an event is a ratio that compares the number of favorable outcomes to the number of possible outcomes. Theoretical probability and experimental results help us make predictions and decisions. • Theoretical probability is what should occur in an experiment, while experimental probability is what actually occurs when repeating a probability experiment. Experimental probability can vary while theoretical is constant. • The Law of Large Numbers tells us that the more times a controlled experiment is performed, the closer the result will approach the theoretical probability. • Permutations are arrangements that include all possible orders while combinations have no regard for order. • To calculate odds, we compare favorable outcomes to unfavorable outcomes, while calculating probability compares favorable outcomes to the entire sample space. • A conditional probability is the probability that an event will occur under a particular circumstance. • Sometimes it is easier to calculate the probability of the complement of an event and to use that result to calculate the probability of the event. • A union involves all events in either sample space while an intersection involves the overlap between two or more sample spaces. • An independent event does not rely on what happened previously, while a dependent event does.	• Calculate and compare theoretical and experimental probabilities. • Use permutations and combinations to compute probabilities of events and solve problems. • Distinguish between probability and odds and calculate each. • Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to calculate conditional probabilities. • Identify the complement of an event and use complements to calculate probabilities. • Understand the meaning of the words “and” and “or” and calculate probabilities involving intersections and unions. • Distinguish between and calculate probabilities involving independent and dependent events

Key Vocabulary: Probability, Theoretical Probability, Experimental Probability, Outcomes, Sample Space, Permutation, Combination, Odds, Two-Way Table, Conditional Probability, Complementary Events, And/Or, Replacement, Independent and Dependent Events

Assessment Evidence	
Performance Tasks: Skittles problem -Students check the validity of a Skittles commercial claim regarding the number of flavor combinations. **AA4(9-12)** Final project - Students work in small groups to create a children's book about probability. **CCE4(9-12)**	**Other Evidence:** Quiz 1 - introduction to probability Quiz 2 - write and solve permutation problems **CCE3(9-12)** Quiz 3 - permutations and combinations Quiz 4 - conditional probability and odds Collect data problem - students collect data and write and solve many types of probability problems **TCC1(9-12)** Quiz 5 - complements, and/or probability, independent and dependent events

Learning Plan
This unit begins with an informal introduction to the idea of probability. Next students learn how to solve permutation and combination problems and to calculate probabilities involving these quantities. As part of this study, students write and solve their own permutation problems in pairs. **CCE3(9-12)** Students also evaluate the validity of a Skittles commercial related to the number of flavor combinations. **AA4(9-12)** Next students learn the difference between probability and odds, terms which are often used interchangeably but which have different meanings. Students learn how to read data from and create a two-way table, as well as how to calculate conditional probabilities. Next we study complements and the ability to use a complement to calculate a probability that would be difficult to calculate directly. Students learn the difference between intersections and unions and calculate the probability of each. In the "collect data problem", students collect data and use it to create a two-way table. They create and solve problems involving odds, conditional probability, and unions and intersections. **TCC1(9-12)** The final topic of study is the difference between independent and dependent events, and calculating the probability of each. The culminating project involves students working in small groups to create a children's book about probability that includes all of the topics that have been studied. **CCE4(9-12)**
Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos; applets

Unit 2 - Univariate Data

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:

S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).
S.ID.A.2 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.
S.ID.A.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
S.ID.A.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
- **MP3:** Construct viable arguments and critique the reasoning of others.
- **MP4:** Model with mathematics.
- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
- **MP7:** Look for and make use of structure.
- **MP8:** Look for and express regularity in repeated reasoning

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

Understandings: Students will understand that...	**Essential Questions:**
• Different types of graphs are appropriate for different types of data. • Different statistics (measures of central tendency and spread) are appropriate for different sets of data. • The Normal distribution can be used to model many real world data sets.	• Why are some types of graphs more appropriate to display a set of data? • How and why are graphs made to be misleading? • Why are some measures of central tendency and spread more appropriate to describe a set of data? • Why are Normal Distributions important in statistics?
Students will know…	**Students will be able to…**
• An appropriate representation of data effectively presents and communicates information. The method of presentation may be selected based on the intended audience. • Vertical scaling creates different visual effects which can cause a graph to be intentionally or unintentionally misleading. • Measures of central tendency and spread are ways to represent the general data in a succinct way. Measures of central tendency and spread are affected differently by extreme values. • The normal curve can describe many real world phenomena. • A Z-score is a standard score, independent of units of measure, which tells the position the raw data has relative to the mean, measured in standard deviations. • If data is normally distributed, given percentages of the data will fall within 1, 2, and 3 standard deviations of the mean.	• Interpret graphs and represent data with appropriate graphs (circle graph, bar graph, dot plot, stem and leaf plot, histogram, box and whisker plot) based on the type of data (qualitative vs quantitative and discrete vs continuous) • 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 • Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers) • Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use empirical rule and standard normal table to estimate areas under the normal curve.
Key Vocabulary: Quantitative Data, Qualitative Data,Circle Graph, Bar Graph, Dot Plot, Stem & Leaf Plot, Discrete, Continuous, Histogram, Left Skewed, Right Skewed, Symmetric, Uniform, Mean, Median, Mode, Range, Standard Deviation, Quartile, Five Number Summary, Interquartile Range (IQR), Box & Whisker Plot, Normal Distribution, Z-Score, Empirical (68-95-99.7) Rule, Standard Normal Table, Percentile	

Assessment Evidence	
Performance Tasks: Family Ages Project - students collect data related to ages of members of their family; data is analyzed and compared through graphs and statistics **CCE4(9-12)** Unit 2 test - summative assessment covering all topics from this unit	**Other Evidence:** Quiz 1 - qualitative vs quantitative; discrete vs continuous; graphs Dot plot and stem plot assessment - students collect data appropriate for each type of graph; they create and discuss the graphs Histogram assessment - students collect data to create a histogram and discuss the graph Quiz 2 - measures of center and range Quiz 3 - boxplots and standard deviation Quiz 4 - normal curve, empirical rule, z-scores Quiz 5 - normal curve - calculating percentiles using std normal table
Learning Plan	
This unit begins with an understanding of the difference between qualitative and quantitative data. Next we study the types of graphs used to depict each type of data. Students distinguish between discrete and continuous data, and learn about histograms. Students discuss the shape of graphs and learn about the qualities of misleading graphs. Next we shift to numerical ways to describe data, specifically one variable statistics. Students review mean, median, mode, and range. They learn about choosing the best measure of center to describe a data set. Next students learn about the five number summary and box and whisker plots. Students complete the Family Ages Project as a summative assessment for the first part of the unit. **CCE4(9-12)** The final one variable statistic that we study is the standard deviation. This leads into a complete study of the normal distribution. Students learn how to calculate probabilities and percentiles using the Empirical (68-95-99.7) rule as well as using z-scores and the standard normal table.	
Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos	

Unit 3 - Bivariate Data

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:

S.ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
S.ID.B.6.B Informally assess the fit of a function by plotting and analyzing residuals.
S.ID.B.6.C Fit a linear function for a scatter plot that suggests a linear association.
S.ID.C.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
S.ID.C.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.
S.ID.C.9 Distinguish between correlation and causation.

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
- **MP3:** Construct viable arguments and critique the reasoning of others.
- **MP4:** Model with mathematics.
- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
- **MP7:** Look for and make use of structure.
- **MP8:** Look for and express regularity in repeated reasoning

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

Understandings: Students will understand that…	**Essential Questions:**
• Linear regression is a powerful statistical tool used to model the	• What is linear regression, and how does it model the

relationship between two quantitative variables and make predictions based on that relationship. ● The strength and direction of the relationship between two variables can be quantified using correlation and the slope of the regression line. ● A linear model may not always be appropriate for every dataset, and the accuracy of predictions depends on the quality of the data and the appropriateness of the model. ● Linear regression models have limitations and should be used with caution when making predictions, particularly when extrapolating beyond the range of the data.	relationship between two variables? ● How can we determine if a linear model is appropriate for a given set of data? ● What do the slope and y-intercept of a linear regression line represent in a real-world context? ● What does it mean when a data point is considered an outlier in the context of linear regression, and how does it affect the model? ● How can the correlation coefficient help us understand the strength and direction of a linear relationship? ● How can linear regression be used to make predictions, and what factors should be considered when making these predictions? ● How do changes in the data, such as adding or removing points, affect the regression line and correlation?
Students will know… ● A scatterplot is used to graph bivariate data. ● Although scatter plots and regression lines may reveal a pattern, the relationship of the variables may indicate a correlation, but not causation. ● The slope and the y-intercept have real world meanings. ● If data contains one or more outliers, assumptions based on the trend line might not be valid.	**Students will be able to…** ● Identify the explanatory and response variable for a set of data. ● Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. ● Compute (using technology) and interpret the correlation coefficient of a linear fit. ● Distinguish between correlation and causation. ● Obtain the equation of a trend line by hand and of the line of best fit using a graphing calculator. ● Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. ● Evaluate the effect of an outlier or an influential observation on the slope and correlation coefficient.
Key Vocabulary: Scatterplot, Explanatory Variable, Response Variable, Positive Association, Negative Association, Correlation, Causation, Correlation Coefficient R, Line of Best Fit, Residual, Outlier, Influential Observation	
Assessment Evidence	
Performance Tasks: Unit 3 project - students measure height and forearm of students in	**Other Evidence:** Quiz 1 - sketching scatterplots, explanatory vs response variable,

class and use this data to determine the line of best fit **TCC3(9-12)**	correlation Quiz 2 - write equation of line of best fit and analyze **CCE4(9-12)**

Learning Plan

This unit builds off of the linear functions unit in Algebra I. Students start by reviewing scatterplots, learning the new terms explanatory and response variable. Students describe scatterplots and sketch scatterplots to illustrate pairs of variables. Students learn about correlation and the caution that correlation does not mean causation. Then students evaluate the best placement for a trend line and review writing equations of lines. **CCE4(9-12)**

Finally students use the TI graphing calculator to find the equation of the best fit line and use that line to answer questions about the variables. The culminating project requires students to measure their classmates height and forearm and create a scatterplot. They use a graphing calculator to find the equation of the line of best fit and use that equation to answer questions about the relationship between the variables. **TCC3(9-12)**

Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos; applets; TI calculator and emulator

Unit 4 - Collecting Data

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:

S.IC.B.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
S.IC.B.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
S.IC.B.6 Evaluate reports based on data.

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
- **MP3:** Construct viable arguments and critique the reasoning of others.
- **MP4:** Model with mathematics.
- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
- **MP7:** Look for and make use of structure.
- **MP8:** Look for and express regularity in repeated reasoning

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.

Understandings: Students will understand that...	**Essential Questions:**
● Data is a fundamental component in making informed decisions in various fields, from scientific research to business and public	● Why is it important to follow appropriate methods of data collection?

policy. ● A well-designed experiment or study reduces bias and increases the reliability of results. ● Bias can systematically affect the results of a study, leading to incorrect conclusions, while variability is inherent in data and must be accounted for.	● How do we design an experiment to ensure that the results are valuable?
Students will know… ● Data must be collected in an appropriate way so that the results that are drawn are meaningful. ● Experiments must use large sample size, randomization, replication, and control groups to ensure valuable results. ● Well designed experiments can prove causation.	**Students will be able to…** ● Identify the population and the sample in a given situation. ● Determine the sampling technique used in a given situation. ● Explain how bias can affect the results of data collection. ● Analyze an experiment that incorporates blocking, randomization, blinding, control, and replication. ● Design an experiment that incorporates blocking, randomization, blinding, control, and replication.
Key Vocabulary: Population, Sample, Simple Random Sample, Stratified Random Sample, Cluster Sample, Convenience Sample, Systematic Sample, Census, Voluntary Response Sample, Bias, Observational Study, Experiment, Treatment, Control Group, Treatment Group, Blocking, Placebo (Effect), Experimental Units, Random Assignment, Replication, Blinding, Double Blinding	
Assessment Evidence	
Performance Tasks: Design own experiment - students describe the design of an experiment of their choosing, using appropriate vocabulary **CCE4(9-12)** Unit 4 test - summative assessment covering all topics from this unit	**Other Evidence:** Quiz 1 - population vs sample, types of sampling methods, bias Design experiment introduction - students design an experiment to determine if eating M&Ms reduces stress prior to learning about experimental design **TCC1(9-12) CCE1(9-12)**
Learning Plan	
This unit focuses on collecting data that is useful for statistical analysis. The two main types of data collection are samples and experiments. The unit begins with an exploration of the difference between a population and a sample. Students learn the different types of sampling methods and which ones are more likely to lead to biased results. Students begin their study of experiments by working in pairs to design an experiment to determine if eating M&Ms reduces stress. This is a formative assessment to see what students already know about experimental design. **TCC1(9-12) CCE1(9-12)**	

After students share their experimental designs, we discuss the vocabulary associated with experiments. Students analyze experiments, making sure that they understand the elements of a good design. Students design their own experiment as a summative assessment for the experiment portion of this unit. **CCE4(9-12)** The unit ends with a summative test which covers all topics.
Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos

Unit 5 - Central Limit Theorem

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:

S.ID.A.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
- **MP3:** Construct viable arguments and critique the reasoning of others.
- **MP4:** Model with mathematics.
- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
- **MP7:** Look for and make use of structure.
- **MP8:** Look for and express regularity in repeated reasoning

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.

Understandings: Students will understand that…	**Essential Questions:**
• The Central Limit Theorem (CLT) shows that, regardless of the population distribution, the distribution of the sample means becomes approximately normal as the sample size increases. • As sample size increases, the variability of the sample mean	• What is the Central Limit Theorem and why is it fundamental in statistics? • Why does the shape of the population distribution become less important as sample size increases?

decreases, making it a more accurate reflection of the population mean. ● The CLT relies on random sampling, which helps ensure that the sample mean is an unbiased estimator of the population mean. ● The normal distribution plays a central role in statistics because of the CLT, which explains why many statistical procedures rely on the assumption of normality.	
Students will know… ● The sample distribution of sample means will guarantee that data is approximated by a normal distribution, even if the original population is not normally distributed, if the sample size is sufficiently large. ● The Central Limit Theorem forms the foundation for the inferential branch of statistics; this theorem describes the relationship between the sampling distribution of sample means and the population that the samples are taken from.	**Students will be able to…** ● Determine if the sample size is large enough to ensure that the distribution of the sample mean is normal. ● Use the Central Limit Theorem to solve problems involving the distribution of the sample mean.
Key Vocabulary: Sampling Distribution, Central Limit Theorem	
Assessment Evidence	
Performance Tasks: Unit 5 project - in pairs, students go online to find distributions (mean and standard deviation) and then write and solve problems involving the distribution of the sample mean (CLT) **TCC1(9-12) TI2(9-12)**	**Other Evidence:** Quiz - conceptual understanding of CLT, along with solving problems
Learning Plan	
This unit begins with a review of the normal curve. Students then investigate the idea of the central limit theorem informally, through desmos (release the hounds) and in class data collection (phone numbers). Students practice problems involving the distribution of the sample mean. Students are formally assessed with a quiz (individual) and a project which they complete in pairs. **TCC1(9-12) TI2(9-12)**	
Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos	

Unit 6 - Inference Involving Means

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:

S.IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
S.IC.A.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0. 5. Would a result of 5 tails in a row cause you to question the model?
S.IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
S.IC.B.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
S.IC.B.6 Evaluate reports based on data.
S.MD.B7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
- **MP3:** Construct viable arguments and critique the reasoning of others.
- **MP4:** Model with mathematics.
- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
- **MP7:** Look for and make use of structure.
- **MP8:** Look for and express regularity in repeated reasoning

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
TCC2(9-12): I can evaluate evidence from multiple perspectives, and recognize their limitations and implications, in order to justify new conclusions.

CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
CCE4(9-12): I can communicate and express my understanding in an authentic, respectful and relevant way, using the most effective mode of expression.
TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.
TI3(9-12): I can formulate and investigate probing questions to further my learning.

Understandings: Students will understand that…

- Confidence intervals provide a range of plausible values for a population mean based on sample data, offering a more informative estimate than a single point estimate.
- A confidence interval provides a range within which the true population mean is likely to fall, but it does not guarantee that the population mean is within that range for any specific sample.
- The width of a confidence interval is determined by the confidence level and the sample size.
- Significance tests are tools for making informed decisions about population means based on sample data.
- The p-value measures the strength of evidence against the null hypothesis, but it does not prove whether the null hypothesis is true or false.
- Statistical significance does not always imply practical importance, and real-world context must be considered when interpreting the results of a significance test.

Essential Questions:

- What does a confidence interval for means represent, and how does it help us estimate the population mean?
- What factors influence the accuracy and reliability of a confidence interval?
- How do we interpret and communicate the meaning of a confidence interval for means in context?
- What does a significance test for means tell us, and how does it help us make decisions about a population mean?
- How do we interpret the results of a significance test for means in context, and what are the potential limitations?

Students will know…

- A confidence interval for means is a range of values used to estimate the true value of a population mean.
- A hypothesis (significance) test for means is a process by which a decision is made between two opposing hypotheses.
- Sample statistics are used to test a claim about the value of the population parameter.

Students will be able to…

- Distinguish between a parameter and a statistic.
- Create a confidence interval based on a sample mean to estimate a population mean.
- Interpret a confidence interval in context.
- Determine the sample size needed for a desired margin of error.
- Write hypotheses for a significance test for means.
- Calculate the test statistic and the p-value, and use this to determine if the result is significant or not.
- Make a conclusion based on the significant or not significant

	result.

Key Vocabulary: Parameter, Statistic, Confidence Interval, Margin of Error, z-star value, Hypothesis Test, Null Hypothesis, Alternative Hypothesis, One-Sided Hypothesis, Two-Sided Hypothesis, Test Statistic, P-value, Alpha-Level (level of significance)

Assessment Evidence

Performance Tasks:	**Other Evidence:**
Unit 6 project - working in pairs, students look online for data involving means; they analyze how the data was collected and create a confidence interval based on the data; they create hypotheses for which they would and would not expect a significant result and test these hypotheses **TCC1(9-12) TCC2(9-12) CCE1(9-12) TI2(9-12) TI3(9-12)**	Chips Ahoy! Problem - students work in pairs to complete a project evaluating the accuracy of a Chips Ahoy! commercial which claims 1000 chips in a bag; students use a confidence interval to test this claim, thus introducing students to the idea of a confidence interval **TCC1(9-12) TCC2(9-12) CCE1(9-12) CCE4(9-12)** Quiz 1 - confidence intervals for means Group quiz - students collect quantitative data from their classmates and create a confidence interval and perform a significance test based on this data **TCC1(9-12) TI3(9-12)** Quiz 2 - hypothesis testing for means

Learning Plan

This unit starts with the distinction between parameters and statistics. Then students complete a project evaluating the accuracy of a Chips Ahoy! commercial which claims 1000 chips in a bag. Students use a confidence interval to test this claim, thus introducing students to the idea of a confidence interval. **TCC1(9-12) TCC2(9-12) CCE1(9-12) CCE4(9-12)**

Students construct and interpret confidence intervals for means, and they determine the sample size needed for a desired margin of error. Next students learn about hypothesis testing (significance testing), the other main idea in inferential statistics. The culminating project requires students to find quantitative data online, analyze how the data was collected, create a confidence interval for the data, and create hypotheses for which they would and would not expect a significant result and test those hypotheses **TCC1(9-12) TCC2(9-12) CCE1(9-12) TI3(9-12)**

Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos

Unit 7 - Inference Involving Proportions

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Common Core State Standards:

S.IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
S.IC.A.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0. 5. Would a result of 5 tails in a row cause you to question the model?
S.IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
S.IC.B.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
S.IC.B.6 Evaluate reports based on data.
S.MD.B7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Standards for Mathematical Practice

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively.
- **MP3:** Construct viable arguments and critique the reasoning of others.
- **MP4:** Model with mathematics.
- **MP5:** Use appropriate tools strategically.
- **MP6:** Attend to precision.
- **MP7:** Look for and make use of structure.
- **MP8:** Look for and express regularity in repeated reasoning

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.
CCE3(9-12): I can show initiative in prompting group discourse and fostering collaboration among others, providing actionable feedback, and working with others to solve problems and/or design products.

TI3(9-12): I can formulate and investigate probing questions to further my learning.

Understandings: Students will understand that…

- Confidence intervals provide a range of plausible values for a population proportion based on sample data, offering a more informative estimate than a single point estimate.
- A confidence interval provides a range within which the true population proportion is likely to fall, but it does not guarantee that the population proportion is within that range for any specific sample.
- The width of a confidence interval is determined by the confidence level and the sample size.
- Significance tests are tools for making informed decisions about population proportions based on sample data.
- The p-value measures the strength of evidence against the null hypothesis, but it does not prove whether the null hypothesis is true or false.
- Statistical significance does not always imply practical importance, and real-world context must be considered when interpreting the results of a significance test.

Essential Questions:

- How does inference for data involving proportions differ from inference for data involving means?
- What does a confidence interval for proportions represent, and how does it help us estimate the population proportion?
- What factors influence the accuracy and reliability of a confidence interval?
- How do we interpret and communicate the meaning of a confidence interval for proportions in context?
- What does a significance test for proportions tell us, and how does it help us make decisions about a population proportion?
- How do we interpret the results of a significance test for proportions in context, and what are the potential limitations?

Students will know…

- A confidence interval for proportions is a range of values used to estimate the true value of a population proportion.
- A hypothesis (significance) test for proportions is a process by which a decision is made between two opposing hypotheses.
- Sample statistics are used to test a claim about the value of the population parameter.
- We work with means for quantitative data; we work with proportions for qualitative data.

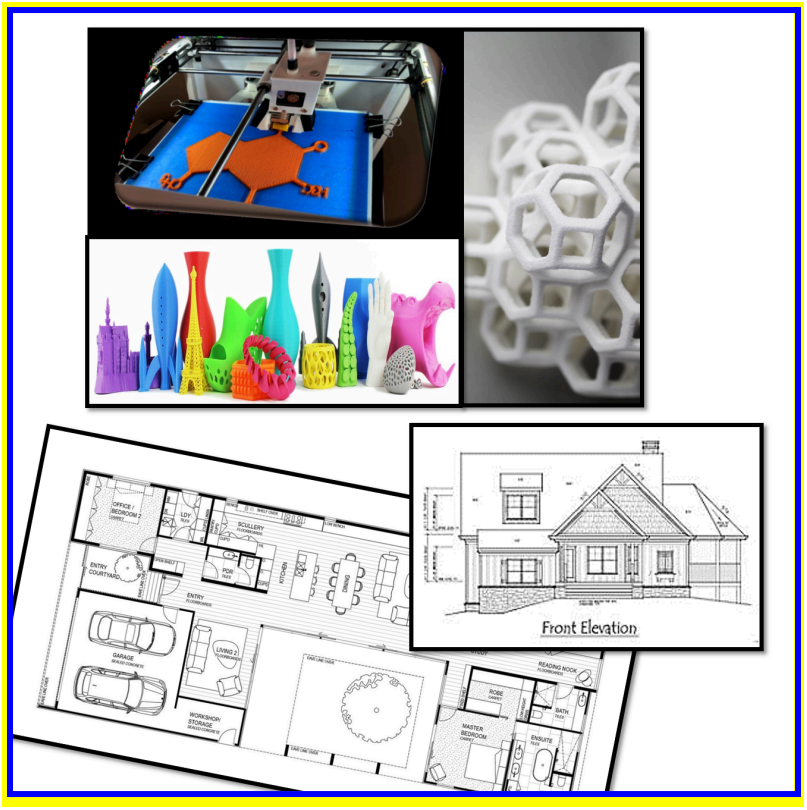
Students will be able to…

- Create a confidence interval based on a sample proportion to estimate a population proportion.
- Interpret a confidence interval in context.
- Write hypotheses for a significance test for proportions.
- Calculate the test statistic and the p-value, and use this to determine if the result is significant or not.
- Make a conclusion based on the significant or not significant result.
- Determine if a problem involves means or proportions.

Key Vocabulary: Parameter, Statistic, Confidence Interval, Margin of Error, z-star value, Hypothesis Test, Null Hypothesis, Alternative Hypothesis, One-Sided Hypothesis, Two-Sided Hypothesis, Test Statistic, P-value, Alpha-Level (level of significance)

Assessment Evidence	
Performance Tasks: Unit 6, 7 group problems - students work in pairs to solve mixed problems from units 6 and 7; they must first identify if the problem involves means or proportions and if it involves a confidence interval or a significance test; then they solve the problem and interpret the result in context **TCC3(9-12) CCE3(9-12)**	**Other Evidence:** Quiz - students collect qualitative data from their classmates; they create a confidence interval and perform a significance test based on this data **TCC1(9-12) TI3(9-12)**
Learning Plan	
This unit continues the work from the previous unit, but switches the focus to qualitative data and proportions. Students begin by creating confidence intervals for proportions, then perform significance tests for proportions. For an interim assessment, students collect qualitative data from their classmates and create a confidence interval and perform a significance test based on the data **TCC1(9-12) TI3(9-12)** For a summative assessment, students work in pairs to solve mixed problems from units 6 and 7. They must first identify if the problem involves means or proportions and if it involves a confidence interval or a significance test; then they solve the problem and interpret the result in context **TCC3(9-12) CCE3(9-12)**	
Teacher Resources: Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot; videos	

COMPUTER AIDED DRAFTING CURRICULUM



Grade Level(s): 9-12

Curriculum Author(s): Kristen Pisano

Course Description: Computer-aided drafting and design systems are used by designers and manufacturers in virtually every industry to create engineering design solutions. In this course, students are learning the basics of CAD software called AutoCAD: creating geometric forms, multiview drawings, 3D models and architectural technical drawings. They learn how to translate initial concepts into accurate, functional designs and explore career options in this hands-on introductory-level course.

(Software: AutoCAD) Prerequisite: Geometry(can be concurrent with*) College Prep *Semester 2 only

Year At A Glance			
Unit Title	**Overarching Essential Question**	**Overarching Enduring Understanding**	**Vision of A Learner "I Can" Statements**
Unit 1: History of CAD, Types of CAD and Employment Opportunities	How has the evolution of CAD technology transformed design practices and career opportunities in various industries?	Students will gain a comprehensive understanding of both the historical development of CAD and its influence on career opportunities, preparing them to navigate and contribute to the evolving field of design technology.	TI4(9-12); TCC4(9-12) ; CCE1(9-12); TCC3(9-12)
Unit 2: Multiview Technical Drawings, Design & 3D Printing	How can CAD be used to accurately represent three-dimensional geometries in multiple views, ensuring clarity and precision with technical drawings?	Students will demonstrate a proficient use of AutoCAD for creating multiview technical drawings requiring a mastery of spatial visualization, precision in dimensioning, and adherence to industry standards to effectively communicate detailed design information.	CCE2(9-12); P2(9-12); TCC3(9-12); TI2(9-12)
Unit 3: Architectural Drafting & Design	How does the process of drafting architectural floor plans integrate design principles, technical skills, and real-world considerations to create accuracy and clarity?	Students will translate architectural ideas and concepts into technical drawings including floor and elevation plans. They will create technical drawings with accuracy, completeness, and adhere to project requirements, including scale, notation and detail.	TCC1(9-12); CCE2(9-12); P3(9-12)

Unit 1 - History of CAD, Types of CAD and Employment Opportunities

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Technology Education CT State Standards
CADD.01 Demonstrate an understanding of the historical and current events related to CADD and the impact on society.
CADD.01.01 Develop a timeline showing important periods that have significance to CADD and explain the impact on society.
CADD.01.02 Evaluate current events that have relevance to process digital information.
CADD.01.03 Describe the development of graphic language in a digital age.
CADD.01.04 Explain the significance of the development Computer Aided Drafting and Design had on society.
CADD.02 Analyze the use of current CADD design technology.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TI4(9-12): I can apply my strengths and anticipate challenges to reach my current and future goals.
- TCC4(9-12): I can integrate my learning to adapt to experiences in the classroom, career and life.
- CCE1(9-12): I can initiate discussions with my peers and teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully with peer-reviewed evidence that is free of bias.
- TCC3(9-12): I can integrate relevant information to produce multiple valid solutions.

Understandings: Students will understand that…

- The historical context of CAD, its evolution, and its profound impact on various industries.
- CAD had an impact on manufacturing.
- There are several different types of career paths that can be taken with CAD training including design, drafting, art, landscaping, architecture etc.

Essential Questions:

- How has CAD technology transformed design and manufacturing processes, and how emerging trends may shape the future of design technology.
- In what ways is CAD being utilized today in both manufacturing industries and across other fields?
- What are some employment opportunities involving CAD?

Students will know…

- What technical drawings are.
- The terminology used to describe the process of creating technical drawings.
- The stages in which technical drawings are produced.

Students will be able to…

- Explain the training needed to become an engineer, architect, designer, or drafter.
- Describe the process of obtaining employment in the technical drawing field and the qualities that employers seek.

• The development of CAD and their impact on manufacturing. • Several types of drafting (aeronautical, mechanical, civil architectural, etc.) • Possible careers involving CAD as well as be able to identify the fastest growing/declining jobs.	• Describe what career prospects and opportunities, including salary ranges, are available in the field of technical drawing.
Key Vocabulary: Aeronautical or Aerospace Drafters; American Institute of Architects; American Society of Mechanical Engineers; Architectural Drafters; Civil Drafters; Computer-Aided-Design/Drafting (CAD); Design Technicians; Drafters; Drafting; Electrical Drafters/mechanical Drafters/ Electronic Drafters/ Engineering Drawings; National Society of Professional Engineers	
Assessment Evidence	
Performance Tasks: • **Performance based assessment:** Job search activity: Students will through web based research and the provided text, answer prompts to allow them to learn about career prospects and opportunities, including salary ranges, and training needed. Students will write a paper describing a possible future career path in detail. **TI4(9-12), TCC4(9-12)** • Class research project/presentation: Timeline of the history and future of CADD. Students collaborate in small groups given a decade to create a slideshow explaining significant advancements of drafting and computer aided drafting development. **CCE1(9-12)**	**Other Evidence:** • **Interim:** Students will answer questions about types of drafting and titles of drafters based on lecture, notes and text reading throughout unit 1. **TCC3(9-12)**
Learning Plan	
• Students will answer questions, research college/trade school or any training expenses for a possible future career. They will answer questions and research the cost of living as well as potential future income. They will research job force opportunities & pay while also looking at jobs that are on the rise as well as declining. They will write a summary of where they see themselves in 10 years.**TCC4(9-12)** • Students will collaborate in small groups, given a decade to research the history of CAD. The class will then create slides for their research and will present their findings for their peers creating a timeline. **CCE1(9-12)**	
Teacher Resources: Technical Drawing 101 with AutoCAD 2023, Douglas Smith, Anotnio Ramirez, Jana Schmidt, SDC Publications.; AutoCAD 2023 Tutorial First Level 2D Fundamentals, Randy H. Shih, SDC Publications; Autodesk: AutoCAD Architecture 2023 Fundamentals, Elise Moss, SDC Publications	

Unit 2 - Multiview Technical Drawings, Design & 3D Printing

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Technology Education CT State Standards

CADD.02.02 Describe physical objects as geometric entities.*
CADD.02.04 Describe and demonstrate the use of graphic communication skills through sketching.*(A3)
CADD.02.05 Evaluate and select appropriate methods of communication for a given problem.*
CADD.02.06 Send and access information through a network.*(A4)
CADD.02.07 Express a design of an object as a 3D model.*(A5)
CADD.02.08 Export and import images/files in a variety of file formats*(A6)
CADD.02.09 Evaluate the choice and placement of dimensions, notes and annotations clearly to communicate design intent.*(A7)
CADD.02.10 Revise a design and update finished drawings appropriately.* (A8)
CADD.02.11 Identify basic geometric elements (e.g., line, circle, rectangle, sphere, and cube).* (A9)
CADD.02.12 Describe objects as geometric entities.*(A1)
CADD.02.13 Describe and apply the following basic geometric concepts to building 3D models: tangent and parallel concentric.*(A10)
CADD.05.10 Place and edit text and fonts.*(E24)
CADD.05.11 Explain and demonstrate the process for creating orthographic, isometric, section views, and auxiliary view.*
CADD.05.12 Place and edit dimensions.*(E26)
CADD.05.13 Generate a 2-D multiview drawing.*(E27)
CADD.05.15 Scale and print hard copy of an output device.*(E29)
CADD.05.16 Explain the use and need for scaled drawings.*(E30)
CADD.06 Demonstrate use and application of alternate view applications and functions.
CADD.06.01 Identify the function of alternate views.
CADD.06.03 Create and edit construction planes through reference geometry.*(G35)
CADD.06.04 Generate/modify geometric components on construction planes.*
CADD.06.05 Create a 2-D drawing from a 3-D model.*(G34)
CADD.06.06 Create a 3-D model from a 2-D drawing.*(G35)
CADD.07 Create assemblies and views in 3-D format.
CADD.07.01 Create an assembly in 3-D geometry.*(F31)
CADD.07.02 Create an exploded view of a 3-D assembly.*(F32)
CADD.08 Explain and Utilize the concepts of sketching and the sketching process used in preliminary design and development.
CADD.08.01 Produce proportional two- and three-dimensional sketches and designs.

CADD.08.02 Use sketching techniques as they apply to a variety of objects.
CADD.08.03 Use freehand graphic communication skills to represent conceptual ideas, analysis, and design concepts.
CADD.08.04 Explain the purpose of sketching and how it applies to design.

Vision of A Learner Attributes: Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
- P2(9-12): I can strengthen my weaknesses by identifying, initiating, and practicing appropriate strategies to become confident in my ability to overcome my challenges.
- TI2(9-12): I can evaluate my objectives and a variety of credible resources to find the best solutions for any challenge.

Understandings: Students will understand that…

- There are industry standards and practices for creating multiview drawings, including layout conventions, symbol usage, and documentation requirements for manufacturing and assembly.
- Multiview drawings use orthographic projection techniques to represent a 3D object in multiple 2D views (such as front, top, side) simultaneously.
- AutoCAD allows for precise dimensioning and annotation of multiview drawings, including adding dimensions, notes, and symbols to convey specific measurements, tolerances, and other design requirements.
- AutoCAD enables the organization of different views and layers within a drawing, facilitating clarity and ease of editing without affecting other parts of the design.
- Each view (front, top, side, etc.) in a multiview drawing shows the object as if viewed along a different plane, providing comprehensive information about its shape, size, and features from various angles.
- They must maintain accuracy in aligning views and dimensions to ensure that the drawing represents the 3D object without distortion or ambiguity.
- Multiview drawings serve as a communication tool between designers, engineers, and manufacturers to convey design

Essential Questions:

- What was it like for drafters before computer technology including software such as AutoCAD or Solidworks?
- How does isometric projection differ from other types of projections (e.g., orthographic) and why do we use it?
- How many and which views are necessary for representing a 3D object with a technical drawing?
- What are the essential tools and features in AutoCAD for creating a multiview drawing?
- How do professionals use CAD software to create and modify isometric drawings efficiently?
- What are the fundamental principles of 3D printing?
- How can 3D printing be used in various industries and applications?
- What are the advantages and limitations of 3D printing?

details, specifications, and assembly requirements effectively. ● 3D printing is a form of additive manufacturing where objects are created layer by layer from digital models, contrasting with traditional subtractive manufacturing methods. ● CAD (Computer-Aided Design) software is essential for creating and preparing 3D models for printing, allowing for precise control over dimensions, geometry, and features. ● Parameters such as layer height, infill density, print speed, and temperature settings are adjusted to optimize print quality, strength, and time efficiency based on the object's requirements.	
Students will know... ● How to differentiate between visible lines and hidden lines and use projection lines to align the drawing. ● How to draw a complex 3-D Isometric shape with proper markings and labels. ● Industry standards and conventions for technical drawings (e.g., ANSI, ISO standards). ● Properly setup a drawing area on AutoCAD. ● How to effectively use the GRID and SNAP options. ● How to create geometric entities such as: lines, circles, arcs, ellipses, and splines. ● Create parallel geometric entities ● When to use the different types of lines. ● The importance of iterative design, revisions, and documentation. ● The capabilities of the 3-D printer and how it works. ● Knowledge of different materials used in 3D printing, their properties and suitability for various applications. ● The fundamental design concepts specific to 3D printing such as tolerances, supports and orientation for optimal print quality. ● Safety protocols when handling 3D printing equipment and materials. ● How to operate a 3D printer, including steps, calibration and maintenance procedures. ● How to work collaboratively involving 3D printing, sharing ideas and integrating different perspectives.	**Students will be able to...** ● Draw basic 2-D Orthographic shapes ● Draw complex 2-D Orthographic shapes w/ hidden lines ● Draw basic 3-D Isometric shapes ● Draw complex 3-D Isometric shapes w/ hidden lines ● Draw basic geometric shapes ● Trim/extend line segments ● Trim/extend circles ● Understand Cartesian and Polar coordinates ● Understand the difference between hidden lines and object lines ● Send drawing to printer/plotter ● Create parallel geometric entities ● Generate a 2-D multiview drawing ● Produce orthographic projects of simple geographic parts. ● Create their own basic 3-D model ● Print their model using the 3-D printer ● Make cavalier, normal and cabinet oblique drawings ● Manipulate 3D models in AutoCAD to achieve isometric, oblique, and perspective views ● Prepare 3D models in AutoCAD to modify for printing, considering factors like scale, orientation and support structures. ● Operate 3D printing equipment including optimizing printer settings, troubleshooting issues, and implementing safety protocols.

Key Vocabulary:

- Isometric shape
- Orthographic shape
- Line
- Hidden line
- Dynamic Input
- Fillet
- Trim
- Extend
- Pedit
- Construction line
- Short break line
- Section line
- Extension line
- Leader line
- Phantom line
- Circle
- Arc
- Precision
- Proportion
- Pictorial sketches
- Oblique
- One point perspective
- Two point perspective
- Cavalier drawing
- Normal drawing
- Cabinet oblique drawing
- Shading: stipple, straight line
- Ellipse
- Spline
- World space
- Origin
- Coordinate system
- Layers
- Model space
- Paper space
- Blocks

Assessment Evidence

Performance Tasks:

- **Performance Task 1: The Guide Plate:** Create a technical drawing by hand of the guide plate provided. This performance task will give students an introduction to drafting prior to the use of computers. Students will use the tools properly including rulers, sharpened pencil and a compass/stencils as needed. They will maintain consistent line weights and spacing, keep the drawing neat and use the educational drafting standards for symbols, line types and dimensioning. **CCE2(9-12),**

- **Performance Task 2: The Bracket:** Technical drawing created on AutoCAD. This performance task involves time management, standard compliance and precision to maintain accuracy throughout the drawing process. They will need to use advanced tools when needed such as Trim, Extend, Offset, and Fillet. To ensure accuracy they will use Object Snaps and Polar Tracking. They will finally add details including dimensions and text annotations of the title block and print.

- **Summative: Design project:** Students will design an object

Other Evidence:

- **Interim:** Sketching (no dimensioning) geometric solids creating multiview drawings using graph paper and a ruler and the proper use of all types of lines. **P2(9-12)**

- **Interim:** Students will answer questions based on lecture and text reading during the unit 2 based on dimensioning and line use.

- **Interim: The Spacer Design:** Students will create a drawing with AutoCAD using new tools learned such as offset, trim, extend.

- **Interim: The Bracket Design:** Students will create a multiview drawing utilizing the new learning about dimensioning and title blocks. Students will have an opportunity afterwards to revise the project through AutoCAD and update the drawing if needed.

that they will 3D print. They will come up with the idea, and create the technical drawing with AutoCAD. This performance task involves time management, standard compliance and precision to maintain accuracy throughout the drawing process. When 3D printing students will work collaboratively and teach the student following them how to use the printer if needed. **TI2(9-12)**	

Learning Plan

- Students will be learning about and producing technical drawings that increase in difficulty level and skill level throughout the unit. As they learn about new tools they will be able to create drawings for more elaborate objects/geometries.
- Students will find and apply resources to identify solutions and manage projects.**CCE2(9-12)**
- Students will ask questions to direct learning and self-advocate while working on drawings.**P2(9-12)**
- Students will design a three dimensional object that they will 3D print and they will operate the 3D printer for their finished product.**TI2(9-12)**

Teacher Resources: Technical Drawing 101 with AutoCAD 2023, Douglas Smith, Anotnio Ramirez, Jana Schmidt, SDC Publications.; AutoCAD 2023 Tutorial First Level 2D Fundamentals, Randy H. Shih, SDC Publications; Autodesk: AutoCAD Architecture 2023 Fundamentals, Elise Moss, SDC Publications

Unit 3 - Architectural Drafting and Design

Desired Results - Goals, Transfer, Meaning, Acquisition

Established Goals:

Technology Education CT State Standards

- ARCH.01 Identify significant historical events and trends that have impacted architecture.
- ARCH.01.01 Discuss current trends in commercial and residential architecture.
- ARCH.01.02 Research and differentiate between design periods that shaped today's structures.
- ARCH.06 Develop technical drawings drafted by hand and computer aided drafting and design(CADD)
- ARCH.06.01Identify,research, develop and explain architectural and construction plans, drawings, diagrams and specifications.
- ARCH.06.02 Draw and sketch by hand to communicate ideas effectively.
- ARCH.06.03 Utilize CADD software to produce technical drawings and architectural proposals.
- ARCH.07 Employ appropriate media to communicate concepts and design.
- ARCH.07.01 Convey information using multi-dimensional drawings.
- ARCH.07.02 Create effective working drawings, and presentation drawing.
- ARCH.07.03 Employ basic model building techniques.
- ARCH.08 Maintain a portfolio to document knowledge, skills and experience in architecture.

Vision of A Learner Attributes: Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TCC1(9-12): I can ask purposeful, insightful questions to find a variety of innovative solutions.
- CCE2(9-12): I can give and receive actionable and relevant feedback with openness to be able to determine meaningful revisions for success.
- P3(9-12): I can accept constructive feedback and use setbacks to adjust my learning journey in order to reach my goals.

Understandings: Students will understand that…

- Architectural floor plans are fundamental tools used to represent the layout, functionality, and spatial relationships of a building, serving as a blueprint for construction and design.
- Different symbols and elements in floor plans, such as doors, windows, and walls, are standardized representations that convey specific information about the physical structure and layout of a space.
- Various drafting techniques and tools, including hand-drafting

Essential Questions:

- What are the fundamental purposes of architectural floor plans?
- How do different elements and symbols in floor plans represent physical spaces and structures?
- What are the steps involved in creating a comprehensive and detailed floor plan with accuracy and clarity.

and digital CAD software, impact the accuracy, precision, and clarity of floor plans, each offering unique advantages and challenges. • CAD software enhances the drafting process by providing advanced tools for creating, modifying, and visualizing floor plans, which helps in improving precision, efficiency, and presentation.	
Students will know... • How floor plans contribute to the overall design and functionality of a building. • What role floor plans play in communication between architects, builders, and clients. • How various drafting tools and techniques contribute to precision and detail in floor plans. • How to create blocks and use blocks to speed up the process when utilizing multiple of the same element such as windows into their drawing. • How to incorporate details such as dimensions, materials, and layout into a floor plan and elevation plan.	**Students will be able to...** • Be able to calculate square footage of a structure with AutoCAD. • Create a basic floor plan according to local building codes. • Identify stairs, walls, doorways, and windows. • Create door and window openings according to uniform sizes. • Create interior and exterior walls with multiline and hatching tools. • Create blocks for uniform items such as windows, doors, ceiling fans, etc… • Create layers including floor plan, plumbing and electrical. • Identify and utilize blocks for switches, outlets, lights, ceiling fans. • Identify sill, floor plate, stud, corner post, top plate, floor joist and ceiling joist. • Identify header, king stud, jack stud and cripple stud. • Be able to calculate rise, run, span and roof pitch. • Identify tread, riser nosing and stringer of steps. • Consult local building codes for appropriate stair sizes and be able to divide the rise to calculate the number of steps.

Key Vocabulary:

- Chamfer
- Open tee
- Open cross
- Closed cross
- Multiline
- Floor plan
- Elevation plan
- Blocks
- Layers
- Freeze
- Hide
- Drawing limits
- Offset
- Trim
- Mline
- Medit
- Ellipse

Assessment Evidence	
Performance Tasks: ● **Project Task 1: The Guest Cottage:** Students will be drafting a drawing for a guest cottage through short video lessons, class lectures and readings from chapter 4 of AutoCAD Architecture 2023 Fundamentals, Elise Moss, SDC Publications. Throughout this drawing they will use new learning to produce the floor plan and plumbing layers with accuracy and precision. They will use architectural style dimensioning and create a window schedule as part of their title block. **TCC1(9-12)** ● **Project Task 2:The Cabin Floor Plan:** Students will be drafting a larger more complex floor plan. This plan will include the use of blocks and an electrical layer in addition to the floor plan and plumbing layers. ● **Project Task 3: The Cabin Elevation Plan:** Students will be drafting a drawing of the vertical elevation of the cabin. Throughout this drawing they will use new learning to produce the siding, roof pitch and exterior details of the side and front view of the cabin. **TCC1(9-12)** ● **Summative Final Project:** Students will create their own unique design and draft of a floor plan and elevation of a one story house (including floor plan, plumbing, electrical and dimensioning layers). After creating a title block they will use the plotter to print their plans to submit professional style drawings of their home. **CCE2(9-12)**	**Other Evidence:** ● **Interim:** Students will answer questions based on lecture and text reading of 4.1 based on drafting architecture and design. ● **Interim:** Students will answer questions based on lecture and text reading for unit 4 based on the creation of walls and new tools such as open tee, open cross, ellipse, arcs and chamfer. **P3(9-12)**

Learning Plan
In this unit students will learn about architectural drawings and how to create a basic floor and elevation plan. They will have a broader understanding of architecture and design and will learn about career paths involving architectural drafting in fields such as architecture, engineering, and construction. ● Students will create drawings through new learning based on the understanding of the basics of architecture and the role of drafting in

building design. **TCC1(9-12)**
- Students will develop fundamental drawing skills necessary for drafting floor plans. They will learn the components and symbols used in architectural floor plans. **CCE2(9-12)**
- Students will explore more complex aspects of floor plan drafting including scaling, dimensioning, and annotation.
- Students will design a complete floor plan for a specific scenario (e.g., family home, community center). They will prepare and present the final floor plan to the class and receive and incorporate feedback from peers and instructors. **P3(9-12)**

Teacher Resources: Technical Drawing 101 with AutoCAD 2023, Douglas Smith, Anotnio Ramirez, Jana Schmidt, SDC Publications.; AutoCAD 2023 Tutorial First Level 2D Fundamentals, Randy H. Shih, SDC Publications; Autodesk: AutoCAD Architecture 2023 Fundamentals, Elise Moss, SDC Publications

Mission-Goals-Objectives

District Goals

The Region 14 Public School District established the following goals:

***Board of Education Goals**:*

1. **Academic Performance** - The district will strive to improve academic performance for all students on multiple assessment indicators and the staff will be committed to continuous improvement.

2. **Communication** - Region 14 will develop partnerships with all stakeholders in the school community to highlight the exemplary programs the district offers.

3. **Safety** - Region 14 will provide safe and secure facilities equipped with technology, enabling a 21st century learning environment that supports the values of the district.

4. **Budget** - Region 14 will prepare a budget that meets the needs of every student and communicates the needs and priorities of Region 14 in a clear and concise manner.

The Region 14 Public School District established the following mission statement:

Board of Education Mission Statement:

The mission of the Region 14 School District is to educate all students to their highest level of academic potential and to teach them the skills and knowledge to become capable, creative, collaborative lifelong learners and responsible members of the world community.

Legal References: Connecticut General Statutes

10-4(c) Duties of boards. Reports. Comprehensive plan for elementary, secondary, vocational, career and adult education.

10-220(b) Duties of boards of education (as amended by P.A. 21-46, Section 13)

P.A. 21-46 An Act Concerning Social Equity and the Health, Safety, and Education of Children

Policy adopted:
cps 5/19
rev 10/19

Mission – Goals – Objectives

Nondiscrimination

Nondiscrimination Policy and Notice

Pursuant to Title IX and its regulations ("Final Rule" released on April 19, 2024), the Region 14 Board of Education has adopted and implemented a policy stating that the District does not discriminate on the basis of sex and prohibits sex discrimination in any education program or activity it operates, including admission and employment.

The Region 14 Public Schools does not discriminate based on race, color, religion, sex, sexual orientation, gender identity or expression, status as a veteran, status as a victim of domestic violence, marital status, pregnancy or related conditions, national origin, protective hairstyles, alienage, ancestry, age, disability, or any other basis prohibited by law and prohibits discrimination, including harassment, in any education program or activity it operates.

The Board shall provide protections from all forms of sex-based harassment, including sexual violence and unwelcome sex-based conduct that creates a hostile environment by limiting or denying a person's ability to participate in or benefit from a school's education program or activity.

The District shall take prompt and effective action to end any sex discrimination in its education programs or activities to provide for the prompt and equitable resolution of sex discrimination complaints, prevent recurrence, and remedy its effects. To that end, the District shall act promptly and effectively in response to information about conduct that reasonably may constitute discrimination, including sexual violence and other forms of sex-based harassment. The district shall also ensure that all school employees are trained about their obligations to address sex discrimination and their obligations to notify or provide contact information for the Title IX Coordinator.

The Region 14 Board of Education Non-discrimination policy includes protections for students, employees, and applicants against discrimination based on pregnancy, childbirth, termination of pregnancy, lactation, related medical conditions, or recovery from these conditions and shall provide reasonable modifications for students based on pregnancy or related conditions, allow for lactation for employees, and access to a clean, private lactation space for students and employees.

The District shall not disclose personally identifiable information obtained through complying with Title IX, with limited exceptions, such as when there had been prior written consent or when the information is disclosed to the parent of a minor.

Retaliation against anyone who, in good faith, makes a report of harassment or discrimination,

Mission – Goals – Objectives

Nondiscrimination Policy and Notice (continued)

files a complaint of harassment or discrimination, serves as a witness, or participates in an investigation or grievance process is also a violation of the Region 14 Board of Education's non-discrimination policy and is prohibited.

The Region 14 Public Schools shall notify *students*, *employees*, *parents*, and *others* of this policy and publish it widely. The Board shall publish a statement that the District prohibits sex discrimination in any education program or activity that it operates and that individuals may report concerns or questions to the Title IX Coordinator. The Board's Non-Discrimination Statement shall be as follows:

The Regional School District No. 14 Board of Education does not discriminate in any employment practice or any educational program or activity on the basis of race, color, religion, national/ethic origin, age, marital status, sex, sexual orientation, gender identity or expression, disability, pregnancy, genetic information, veteran status, status as a domestic violence victim, or any other basis prohibited by Connecticut state and/or federal laws. Regional School District No. 14 further provides equal access to the Boy Scouts, Girl Scouts, and all other designated youth groups. Any person having inquiries concerning Regional School District No. 14 Public Schools' compliance with its nondiscrimination policies and procedures, including compliance with Section 504, Title VI or Title IX, should contact:

District Title IX Coordinator:

Dina Ericson
Title IX Coordinator/Director of Student Services
DEricson@ctreg14.org
Regional School District 14
5 Minortown Road
Woodbury, CT 06798
(203) 263-6356

Mission – Goals – Objectives

Nondiscrimination Policy and Notice (continued)

District's Other Designees Under Section 504

The Region 14 Public School District is required not to discriminate on the basis of sex by Title IX and its implementing regulations. Inquiries about Title IX may be referred to the District's Title IX Coordinator, the U.S. Department of Education's Office for Civil Rights, or both.

The U.S. Department of Education's Office for Civil Rights Contact Information:

U.S. Department of Education
Office for Civil Rights
Lyndon Baines Johnson Department of Education Bldg
400 Maryland Avenue, SW
Washington, DC 20202-1100
OCR@ed.gov
800-421-3481

To report information about conduct that may constitute sex discrimination or make a complaint of sex discrimination under Title IX, please refer to The Region 14 Public School's non-discrimination policy and grievance procedures (**Title IX Policy and Administrative Regulation**) Policy #4000.1/4200.1 and 5145.44. Any person may also report sex discrimination, including harassment, using the contact information listed for the Title IX Coordinator.

The Region 14 Public School's non-discrimination policy and grievance procedures (**Title IX Policy and Administrative Regulation**) Policy #4000.1/4200.1 and 5145.44.

(cf. 4000.1 – Title IX)
(cf. 4111 – Recruitment and Selection)
(cf. 4111.1/4211.1 – Affirmative Action)
(cf. 4118.11/4218.11 – Nondiscrimination)
(cf. 4118.112/4218.112 – Sex Discrimination and Sexual Harassment in the Workplace)
(cf. 4118.113/4218.113 – Harassment)
(cf. 5145.4 – Nondiscrimination)
(cf. 5145.5 – Sexual Harassment)

Mission – Goals – Objectives

Nondiscrimination Policy and Notice (continued)

(cf. 5145.51 – Peer Sexual Harassment)
(cf. 5145.52 – Harassment)
(cf. 5145.6 – Student Grievance Procedure)
(cf. 6121 – Nondiscrimination)
(cf. 6121.1 - Equal Educational Opportunity)

Legal Reference: Title VII, Civil Rights Act, 42 U.S.C. 2000e, et seq.
29 CFR 1604.11, EEOC Guidelines on Sex Discrimination.
Title IX of the Educational Amendments of 1972, 20 U.S.C. 1681 et seq.
Title IX Final Rule, May 6, 2020
Age Discrimination in Education Act, 29 U.S.C. §621
Americans with Disabilities Act, 42 U.S.C. §12101
Section 504 of the Rehabilitation Act of 1973, 29 U.S.C. §794
Title II of the Genetic Information Act of 2008
Title VI of the Civil Rights Act of 1964, 42 U.S.C. §2000d et. Seq.
34 CFR Section 106.8(b), OCR Guidelines for Title IX.
Definitions, OCR Guidelines on Sexual Harassment, Fed. Reg. Vol 62, #49, 29 CFR Sec. 1606.8 (a0 62 Fed Reg. 12033 (March 13, 1997) and 66 Fed. Reg. 5512 (January 19, 2001)
20 U.S.C. 7905 (Boy Scouts of America Equal Access Act)
Meritor Savings Bank. FSB v. Vinson, 477 U.S. 57 (1986)
Faragher v. City of Boca Raton, No. 97-282 (U.S. Supreme Court, June 26,1998)
Gebbser v. Lago Vista Indiana School District, No. 99-1866, (U.S. Supreme Court, June 26,1998)
Davis v. Monro County Board of Education, No. 97-843, (U.S. Supreme Court, May 24, 1999.)
The Vietnam Era Veterans' Readjustment Act of 1974, as amended, 38U.S.C. §4212
Title II of the Genetic Information Nondiscrimination Act of 2008
Connecticut General Statutes
46a-51 Definitions (as amended by PA 17-127, PA 21-2 and PA 22-82)
46a-58 Deprivation of rights. Desecration of property. Placing of burning cross or noose on property. Penalty. (as amended by PA 17-127 and PA 22-82)

Mission – Goals – Objectives

Nondiscrimination
Legal reference continued

46a-60 Discriminatory employment practices prohibited. (as amended by PA 17-127 and PA 21-69 and PA 22-82)
46a-81a Discrimination on basis of sexual orientation: Definition
10-15c Discrimination in public schools prohibited. School attendance by five-year olds. (Amended by P.A. 97-247 to include "sexual orientation" and P.A. 11-55 to include "gender identity or expression")
10-153 Discrimination on account of marital status.
17a-101 Protection of children from abuse.
PA 17-127, An Act Concerning Discriminatory Practices Against Veterans, Leaves of Absence for National Guard Members…
Public Law 111-256
Meacham v. Knolls Atomic Power Laboratory 128 S.Ct. 2395, 76 U.S.L.W. 4488 (2008)
Federal Express Corporation v. Holowecki 128 S.Ct. 1147, 76 U.S.L.W. 4110 (2008)

Kentucky Retirement Systems v. EEOC 128 S.Ct. 2361, 76 U.S.L.W. 4503 (2008)

Sprint/United Management Co. v. Mendelsohn 128 S.Ct. 1140, 76 U.S.L.W. 4107 (2008)

Bostock v. Clayton County, Georgia, 140 S.Ct. 1731, 2020 WL3146686 (June 15, 2020)

2024 Amendments to the U.S. Department of Education's Title IX Regulations ("Final Rule")

Policy adopted:
cps 7/24

Mr. Brian Murphy
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Board of Education Meetings
January - December 2025
All Regular Meetings begin at 6:00 pm
The Flanders Room
Mitchell Elementary School
****except where noted ****

Day	Date	
Monday	January 13	
Monday	February 3	Bethlehem Elementary School Library
Monday	March 3	Superintendent's 2025/2026 Budget Presentation to the BOE
Monday	March 10	Budget Workshop
Monday	March 17	Budget Workshop
Monday	March 24	Budget Presentation to the Towns' BOS and BOF (WMS Cafeteria)
Tuesday	**March 25**	**Public Hearing (NHS Auditorium)**
Monday	April 7	Regular Meeting/Meeting to Adopt BOE 25-26 Budget/Bethlehem Elementary School
Monday	May 5	District Meeting (Budget) & Regular BOE Meeting
Tuesday	**May 6**	**Budget Referendum to Vote on 25-26 Budget Proposal**
Thursday	**May 8**	**District Meeting for the Purpose of BoE Member Nominations**
Monday	June 2	
Thursday	**June 5**	**Election of New Board Members (Town Voting Stations)**
Monday	July 14	Regular Meeting/Election of BoE Officers
Monday	August 18	
Monday	September 8	
Monday	October 6	Bethlehem Elementary School Library
Monday	November 3	
Monday	December 1	