Unit Two & Three Information

Curriculum Map: Operations with Polynomials & Polynomial Functions

Content Descriptors:
Concept 1: Operations with Polynomials
Concept 2: Finding the zeros of a polynomial function
Concept 3: Graphing polynomial functions
Concept 4 : Applications with Polynomials

Content from Frameworks: Operations with Polynomials
Polynomial Functions

Unit Length: Approximately 54 days

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Curriculum Map

Unit Rational:

Unit 2: This unit develops the structural similarities between the system of polynomials and the system of integers. Students draw on analogies between polynomial arithmetic and base-ten computation, focusing on properties of operations, particularly the distributive property. Students connect multiplication of polynomials with multiplication of multi-digit integers, and division of polynomials with long division of integers. Students will find inverse functions and verify by composition that one function is the inverse of another function.

Unit 3: In this unit, students continue their study of polynomials by identifying zeros and making connections between zeros of a polynomial and solutions of a polynomial equation. Students will see how the Fundamental Theorem of Algebra can be used to determine the number of solutions of a polynomial equation and will find all the roots of those equations. Students will graph polynomial functions and interpret the key characteristics of the function.

Prerequisites: As identified by the GSE Frameworks

Length of Unit: 54 Days

- ✓ Combining like terms and simplifying expressions
- ✓ Long division
- ✓ The distributive property
- ✓ The zero property
- ✓ Properties of exponents
- ✓ Simplifying radicals with positive and negative radicands
- ✓ Factoring quadratic expressions
- ✓ Solving quadratic equations by factoring, taking square roots, using the quadratic formula and utilizing graphing calculator technology to finding zeros/ x-intercepts
- ✓ Observing symmetry, end-behaviors, and turning points (relative maxima and relative minima) on graphs

Concept 1	***Concept 2***	***Concept 3***	***Concept 4***
Operations with Polynomials	Finding the zeros of a polynomial function	Graphing polynomial functions.	Application of Polynomial functions and finding the inverse
GSE Standards	***GSE Standards***	***GSE Standards***	***GSE Standards***

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MGSE9-12.A.SSE.1
Interpret expressions that represent a quantity in terms of its context

MGSE9-12.A.SSE.1a Interpret parts of an expression, such as terms, factors, and coefficients.

MGSE9-12.A.SSE.1b Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors

MGSE9-12.A.SSE.2
Use the structure of an expression to rewrite it in different equivalent forms. For example, see x4 – y4 as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 – y^2)(x^2 + y^2)$.

MGSE9-12.A.CED.4
Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

MGSE9-12.A.APR.1
Add, subtract, and multiply polynomials; understand that polynomials form a system analogous to the integers in that they are closed under these operations.

MGSE9-12.A.APR.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)

MGSE9-12.N.CN.9
Use the Fundamental Theorem of Algebra to find all roots of a polynomial function.

MGSE9-12.A.APR.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)

MGSE9-12.A.APR.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.

MGSE9-12. F.IF.7
Graph functions expressed algebraically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

MGSE9-12. F.IF.7c
Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

MGSE9-12.F.IF.9
Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

MGSE9-12.A.REI.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.

MGSE9-12.F.IF.4
Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts;

MGSE9-12.F.BF.1
Write a function that describes a relationship between two quantities.

MGSE9-12.F.BF.1b
Combine standard function types using arithmetic operations in contextual situations (Adding, subtracting, and multiplying functions of different types).

MGSE9-12.F.BF.1c
Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height 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.

MGSE9-12.F.BF.4b
Verify by composition that one function is the inverse of another.

MGSE9-12.A.APR.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. **MGSE9-12.A.APR.4** Prove polynomial identities and use them to describe numerical relationships. **MGSE9-12.A.APR.5** Know and apply that the Binomial Theorem gives the expansion of $(x + y)$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle. **MGSE9-12.A.APR.6** Rewrite simple rational expressions in different forms using inspection, long division, or a computer algebra system; 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 $b(x)$.		interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; ~~and periodicity~~.	
Lesson Essential Question	***Lesson Essential Question***	***Lesson Essential Question***	***Lesson Essential Question***
• How can you write a polynomial in standard form? • How are basic operations used in simplifying polynomial expressions? • How is synthetic and long division used to divide polynomials? • What are the different methods for factoring polynomials? • How do we use polynomials to	• How is factoring used to find the zeros (roots, solutions, x-intercepts) and to aid in graphing? • What does a complex root mean when it comes to graphs? • How is synthetic used to find the zeros? • How is the Fundamental Theorem of Algebra used in finding roots and graphing?	• How can you use a graph to write the polynomial function, identifying key features of the graph? • How does the degree of a polynomial affect its graph? • How do I use the process of completing the square to show and interpret characteristics of a quadratic functions?	• How do I describe a relationship between two quantities? • How do I combine functions in context? • How do I verify and read values of a composition of one function to another?

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solve problems? • How is Pascal's triangle used in binc expansion?		• How do you determine if a polynomial function is even, odd or neither**?** • How do I compare properties of and write functions (algebraically, graphically, numerically in tables and verbal descriptions)?	
Vocabulary	***Vocabulary***	***Vocabulary***	***Vocabulary***
Coefficient Polynomial Monomial Leading Coefficient Term Binomial Pascal's Triangle Degree Trinomial Constant Rational Root Theorem Synthetic Division Remainder Theorem	Zeros Factor Roots Fundamental Theorem of Algebra Linear Fundamental Theorem of Algebra	End Behavior Range Domain Multiplicity Relative Minimum Relative Maximum Even function Odd function Cubic function	Composition Inverse
Resources – Concept 1	***Resources – Concept 2***	***Resources – Concept 3***	***Resources – Concept 4***
❖ Graphic Organizer Factoring Polynomials Blank ❖ Graphic Organizer Long Division Blank ❖ Graphic Organizer Rational Root ❖ Polynomial Teacher Notes (A.SSE.1,2, A.APR.1&3) ❖ Fundamental Theorem Power Point ❖ Multiple representations and explanations of Pascal's triangle(A.APR.5) Website	❖ Graphic Organizer – Zeros of a polynomial function Blank ❖ Graphic Organizer – Theorems on Finding Roots ❖ Finding Rational Zeros – Notes Examples(A.APR.2&3) ***These tasks were taken from the GSE Frameworks.*** ➢ Factors, zeros and roots (A.APR.3) guided notes and practice Teacher Student ➢ Polynomial Project (A.APR.2,3, N.CN.8,9) *great practice Teacher Student	❖ Polynomial Practice (F.IF.7) ❖ Culminating Practice ❖ Even and Odd Functions ***These tasks were taken from the GSE Frameworks.*** ❖ Discovering polynomial characteristics (F.IF.7&9) great discovery activity Teacher Student ❖ Culminating Polynomial Project 2 Teacher Student	Review Activity for F.BF.1 ❖ Average Rate of Change Guided Notes ❖ Examples ❖ Practice ❖ Composition of Functions notes and practice (Power Point) ❖ Composition Practice (with domain restrictions) ❖ Composition of Functions Practice ❖ Composition of Functions Homework ❖ Finding Inverses Notes (Power Point) ❖ Graphic Org - Inverses ❖ Guided Notes – Finding the Inverse ❖ Finding & Verifying Inverses

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❖ Pascal's Triangle (A.APR.5) – Graphic Organizer and practice ❖ Pascal's Pumpkins (A.APR.5) – Graphic Organizer Penguins ***These tasks were taken from the GSE Frameworks.*** ➢ Classifying Polynomials (A.SSE.1&2) guided notes Teacher Student ➢ We've Got to Operate (A.SSE1,2A.APR.1) practice (use #6 for extension) Teacher Student ➢ Divide (long division and synthetic) guided notes and practice Teacher Student			
Concept 1 Differentiated Activities	***Concept 2 Differentiated Activities***	***Concept 3 Differentiated Activities***	***Concept 4 Differentiated Activities***
These tasks were taken from the GSE Frameworks. Polynomial identities activity (A.APR.3)		❖ Polynomial FAL (F.IF.7&9)	❖ Culminating Packet (Review) ❖ Human Polynomials Project ❖ Cantilever Task

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At the end of Unit students should be able to say "I can…"

- perform operations on polynomials (addition, subtraction multiplication, long division, and synthetic division)
- identify and which operations are closed under polynomials and explain why
- write polynomials in standard and factored forms
- perform binomial expansion by applying Pascal's Triangle
- find the inverse of simple functions and verify inverses with the original function
- apply the Remainder Theorem to determine zeros of polynomial functions
- utilize the Rational Root Theorem to determine possible zeros to polynomial functions
- solve polynomial equations using algebraic and graphing calculator methods
- apply the Fundamental Theorem of Algebra to determine the number of zeros of polynomial functions
- construct rough graphs of polynomial functions, displaying zeros, relative maxima's, and end-behaviors
- identify key features of graphs of polynomial functions
- find the intersection of a linear and a polynomial equation