Grade: Math II Lesson Title: Operations on Polynomials

Unit 2: Quadratic Functions - Representations **Time Frame:** 8 - 9 Days

Essential Question:

- How do the arithmetic operations on numbers extend to polynomials?

Targeted Content Standard(s):

A.SSE.1 Interpret expressions that represent a quantity in terms of its context.
a)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.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 $(x^2 – y^2)(x^2 + y^2)$.
APR.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.

Student Friendly Learning Targets

I can…

- Add, subtract, and multiply polynomials
- Interpret expressions.
- View complicated expressions by its parts.
- Identify ways to rewrite quadratic expressions.

Targeted Mathematical Practice(s):

- ☐ 1 Make sense of problems and persevere in solving them.
- ☒ 2 Reason abstractly and quantitatively.
- ☐ 3 Construct viable arguments and critique the reasoning of others.
- ☐ 4 Model with mathematics.
- ☐ 5 Use appropriate tools strategically.
- ☐ 6 Attend to precision.
- ☒ 7 Look for and make use of structure.
- ☐ 8 Look for an express regularity in repeated reasoning.

Supporting Content Standard(s): *(optional)*

A.CED.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.~~*

Explanation of Rigor: *(Fill in those that are appropriate.)*

Conceptual:	**Procedural:**	**Application:**
Students will interpret complicated expressions by viewing one or more of their parts.	Students will add, subtract, and multiply polynomials, identify ways to rewrite quadratic expressions, and factor and complete the square on quadratic functions.	

Vocabulary:

Polynomial	Trinomial	Standard form of a polynomial Leading coefficient	Combine like terms
Monomial	Degree of a polynomial		Distributive property (distribution)
Binomial			

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Evidence of Learning (Assessment):

Pre-Assessment: no pre-assessment for this unit

Formative Assessment(s): Operations on Polynomials, Tiling the Floor

Summative Assessment: This lesson will be assessed at the end of the unit

Self-Assessment:

Lesson Procedures:

Segment 1

Approximate Time Frame: 45-50 minutes	**Lesson Format:** ☒ Whole Group ☐ Small Group ☐ Independent	**Resources:**
Focus: Introducing polynomials with an emphasis on important vocabulary	☒ Modeled ☐ Guided ☒ Collaborative ☐ Assessment	**Modalities Represented:** ☐ Concrete/Manipulative ☐ Picture/Graph ☐ Table/Chart ☒ Symbolic ☒ Oral/Written Language ☒ Real-Life Situation

Math Practice Look For(s): **MP#2: Reason abstractly and quantitatively.** Students will extend the properties of real numbers to polynomial expressions.	**Differentiation for Remediation:** **Differentiation for English Language Learners:** Pre-teach vocabulary **Differentiation for Enrichment:**
Potential Pitfall(s)	**Independent Practice (Homework):** Practice problems involving combining like terms and identifying different degree polynomials using appropriate vocabulary
Steps: - Present students with a variety of polynomial expressions (including expressions with different numbers of terms, different degrees and different leading coefficients). Without discussing lesson vocabulary, ask students to individually group the expressions in any manner they see fit. - Once students have sorted their expressions, group them together and ask students to explain their choices in sorting the polynomial expressions. Some may have sort them based on	**Teacher Notes/Reflections:**

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the number of terms while others sort them by degree and others sort them based on the leading coefficient. Hold class discussion on the different assortments which leads to the discovery of the need for the lesson's vocabulary.
- Define polynomial, monomial, binomial, trinomial (tie to the vocabulary term "non-linear").
- Discuss prefixes mono, bi, and poly and connect to prior knowledge.
- Define degree and discuss briefly how to determine degree of a polynomial.
- Show students how to manipulate a polynomial into standard form.
  o For example, $y + 5y^3 - 7y^6 - 2y^2 + 10$
- Define leading coefficient.
- Use given polynomials modeling real-world situations to estimate values between two points and have students talk with their partners about each problem.
  o For example:
Companies overseas produce many of the electronic devices that we use every day. The number P (in thousands) of devices produced by a particular company between 2006 and 2012 can be modeled by the following equation where t is the number of years since 2006: $P = 3t^2 - 2t + 10$
How many electronic devices were produced in 2008?
If the company continues to produce at this rate, how many devices will they produce in 2020?	

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Segment 2

Approximate Time Frame:

90 – 100 minutes

Lesson Format:

☒ Whole Group
☐ Small Group
☐ Independent

☒ Modeled
☒ Guided
☐ Collaborative
☐ Assessment

Resources:

Algebra tiles (if desired)

Focus:

Adding, subtracting, and multiplying polynomials (including monomial x polynomial and binomial x binomial).

Modalities Represented:

☐ Concrete/Manipulative
☐ Picture/Graph
☐ Table/Chart
☒ Symbolic
☐ Oral/Written Language
☐ Real-Life Situation

Math Practice Look For(s):

MP#2: Reason abstractly and quantitatively. Students will extend the properties of real numbers to polynomial expressions.

Differentiation for Remediation:

Differentiation for English Language Learners:

Differentiation for Enrichment:

Potential Pitfall(s):

Students may make mistakes when a -1 needs to be distributed to a polynomial or make sign errors.

Students may struggle with connecting knowledge of finding area to polynomials.

Students may distribute the exponent when a binomial is squared instead of expanding first.

Independent Practice (Homework):

Practice problems for all combinations of polynomials to reinforce correct procedures when using the distributive property.

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Essential Question:

- How do the arithmetic operations on numbers extend to polynomials?

Steps:	**Teacher Notes/Reflections:**

- Give students an example of combining like terms (no x^2 terms).
  o For example, $2x + 5 + 3x - 10 + 4 + 17 - 11x$
- Ask students to recall the appropriate method for simplifying this expression.
- Then use the same expression from above, but add some x^2 terms
  o Ask students to give suggestions for simplifying this expression.
  ▪ The goal is to have students arrive at the conclusion that the same rules of addition and subtraction apply to polynomials of degree 2.
- Provide students several examples to work on with a partner, including addition and subtraction.
  o Include an example like this one, paying close attention to how the subtraction affects the second polynomials:
  ▪ $(-4b^2 - 2b + 8) - (4b^3 + 3b^2 - 5)$
- Multiplying a monomial by a polynomial
  o (Brief distributive property review) Give students an example of a constant multiplied by a polynomial of degree 1.
  o Follow up with a monomial multiplied by a polynomial of degree 2.
  o Continue providing examples as needed, including opportunities for students to use distribution and combining of like-terms.
  o For example:
  ▪ $3b(-6b^2 + b + 9) - b^3(b^2 - 7b^2 + 5)$
- Multiplying two binomials using the distributive property.
  o Using distributive property as a foundation, demonstrate the procedure for multiplying two binomials.
  o Emphasize the distributive property and show multiple ways to approach the procedure.
  o Provide several examples for students to practice with a partner including ones similar to these:
  ▪ $(x + 3)(x + 4)$
  ▪ $(x - 3)(x - 2)$
  ▪ $(x - 1)(x + 6)$
  ▪ $(x + 2)^2$
  ▪ Make sure that you cover perfect squares and difference of squares to prepare for use in factoring and completing the square in Unit 3.
- Apply the concepts and procedures of multiplying two binomials to a real-world situation.
  o For example,
  ▪ *An artist needs to frame a picture using a matte. Using the dimensions in the diagram below, write an expression that represents the area of the*	

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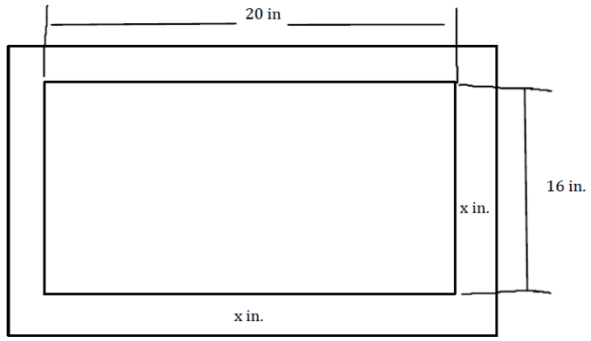
picture and matte.  	

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Essential Question:

- How do the arithmetic operations on numbers extend to polynomials?

Segment 3

Approximate Time Frame:

100-120 minutes

Lesson Format:

☒ Whole Group
☒ Small Group
☐ Independent

☒ Modeled
☒ Guided
☒ Collaborative
☐ Assessment

Resources:

Focus:

Multiplying two polynomials with degree > 1.

Modalities Represented:

☐ Concrete/Manipulative
☐ Picture/Graph
☐ Table/Chart
☒ Symbolic
☐ Oral/Written Language
☐ Real-Life Situation

Math Practice Look For(s):

MP#2: Reason abstractly and quantitatively. Students will extend the properties of real numbers to polynomial expressions.

Differentiation for Remediation:

Differentiation for English Language Learners:

Differentiation for Enrichment:

Potential Pitfall(s):

Students may attempt to "do these problems in their heads" instead of thoroughly writing out each step in the distribution procedure, which would cause students to lose terms.

Students may neglect negative coefficients when multiplying two terms and when combining like terms.

Independent Practice (Homework):

Steps:

- Review multiplying two binomials and use this as a bridge to multiplying polynomials with larger degree.
- As a large group, work through one example like this one below:
  - $(m^2 + 2m - 1)(2m^2 - 7m + 4)$
  - Be sure to use the term distribution to connect with previous learning.
- Create a set of practice problems for students to work on with a partner.
- Have students share their work in some way (on the board, paper pass, etc.) to generate discussion about proper procedures and common errors when multiplying polynomials.
- Take a Chance on Polynomials Activity
  - Pre-cut the poly-cards and enrichment set of poly-cards.
  - Pre-cut the dice out of cardstock (not regular paper) and then assemble them.
    - If you choose, you can use regular 6-sided dice and assign the numbers to the necessary operations.

Teacher Notes/Reflections:

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Essential Question:

- How do the arithmetic operations on numbers extend to polynomials?

○ Divide your class into groups of 2 students and give each group one activity packet. ○ If desired, the number of cards and trials can be reduced.	

Segment 4

Approximate Time Frame: 45-50 minutes	**Lesson Format:** ☐ Whole Group ☐ Small Group ☒ Independent ☐ Modeled ☐ Guided ☐ Collaborative ☒ Assessment	**Resources:** Operations of Polynomials Assessment
Focus: Assessing student understanding of the operations on polynomials as they relate to operations on real numbers.		**Modalities Represented:** ☐ Concrete/Manipulative ☐ Picture/Graph ☐ Table/Chart ☒ Symbolic ☒ Oral/Written Language ☐ Real-Life Situation

Math Practice Look For(s): **MP#2: Reason abstractly and quantitatively.** Students will extend the properties of real numbers to polynomial expressions.	**Differentiation for Remediation:** **Differentiation for English Language Learners:** **Differentiation for Enrichment:**
Potential Pitfall(s):	**Independent Practice (Homework):**
Steps: - Use assessment ***"Operations on Polynomials"***	**Teacher Notes/Reflections:**