Rich Mathematical Task – Algebra I – *Flower Gardens*

Task Overview/Description/Purpose:

- The purpose of this task is to deepen students´ understanding of the laws of exponents as they apply to adding, subtracting, multiplying, and dividing polynomials.
- In this task, students will use problem solving to explore real world application of polynomial expressions to develop mathematical understanding of adding, subtracting, multiplying, and dividing polynomials.
- Students will apply the laws of exponents as they relate to adding, subtracting, multiplying, and dividing polynomials.
- Students will determine area to represent space needed to construct flower beds.
- Students will use models to create visual representations of the area.
- Students will also have to identify which operation is needed to determine the area and, in some cases, multiple operations could be used to determine the space.

Standards Alignment: Strand – *Equations and Inequalities*

Primary SOL: A.2a, b The student will perform operations on polynomials, including

a) applying the laws of exponents to perform operations on expressions.
b) adding, subtracting, multiplying, and dividing polynomials

Related SOL (within or across grade levels/courses): 6.5

Learning Intention(s):

- **Content** - I am learning to model simplifying monomial expressions using the laws of exponent as well as determine the sums, differences, products, and quotients of polynomial expressions when used in practical situations.
- **Language** - I am learning to justify my reasoning for solving a problem with mathematical language and produce evidence to support my solutions.
- **Social** - I am learning to communicate and justify my reasoning with my collaborative team.

Success Criteria (Evidence of Student Learning)

- I can model sums, differences, products, and quotients of polynomials.
- I can determine sums and differences of polynomials.
- I can determine products and quotients of polynomials.

Mathematics Process Goals

Problem Solving	• Students will apply problem solving strategies to determine the operations (adding, subtracting, multiplying, or dividing) required to solve problems involving polynomial expressions.
Communication and Reasoning	• Students will communicate the thinking process for evaluating polynomials using addition, subtraction, multiplication, and division. • Students will support their reasoning and justification with solution steps. • Students will use mathematical language to express ideas with precision.
Connections and Representations	• Students will use multiple representations to explore and model their problems. • Students will make mathematical connections that are relevant to the context of the problems.

Task Pre-Planning	
Approximate Length/Time Frame: 40-45 minutes	
Grouping of Students: This task can be used as an introductory or summative assessment. Introductory Task - Students should be combined in groups of two. Students will read the task and work as a pair to determine the necessary operations needed to perform the task. Summative Task - Students can be expected to complete the task individually then pair in groups of no more than three to compare solutions and justifications.	
Materials and Technology: • Grid Paper • Rulers • Highlighters	**Vocabulary:** • Polynomial Expressions • Laws of Exponents • Models • Solutions
Anticipate Responses: See the Planning for Mathematical Discourse Chart (columns 1-3).	

Task Implementation (Before)

Task Launch:

Prior to implementation of the task, have a classroom discussion about gardening. Does anyone have parents who are or use professional landscapers? (ELL-identify what a landscaper is.) Has anyone ever been to a botanical garden? Do any of you have a garden at home? Visual representations could be helpful here. Consider the following questions as you introduce the task:

- How will students access the prior knowledge and vocabulary needed to understand the task? Ask students if they understand how landscapers use math to determine the amount of space available for each display of plants. Discuss area and determine the formulas used for a variety of shapes.
- Ask: "If you were a landscaper and you had a rectangular/square shape of space to put flowers in, what would you do to determine your area of space? What would you do if you had to combine or reduce the amount of space you were working with?"

Task Implementation (During)

Directions for Supporting Implementation of the Task

- Monitor – The teacher will observe and listen to students as they work independently or collaboratively on the task. The teacher will engage with students by asking assessing or advancing questions as necessary (see attached *Question Matrix).*
- Select – The teacher will select 2-3 students to share their strategies to share with the whole group. Determine which models will enhance the understanding of polynomials involving addition, subtraction, multiplication, and division.
- Sequence – The teacher will determine the order students will present to the whole group. One suggestion is to look for one common misconception and to correct responses to share.
- Connect – The teacher will consider ways to facilitate connections between different student representations.

Suggestions for Additional Student Support:

- Provide scaffolded support with determining which operation to use when interpreting the problems. Consider the use of hint cards (cards that provide a hint as to the next step) or organizers to support thinking.
- Encourage appropriate use of mathematical vocabulary. Substitute student vocabulary with math terms. For example: encourage students to say "*x* to the second power" instead of "*x* two."
- Provide highlighters to focus on important information and problem directions.
- Allow students the opportunity to provide oral justifications and explanations.
- Allow a graphic organizer to assist with applying the laws of exponents.

Using Prior Knowledge- (possible extension for students who may complete the task prior to the whole group): Polly only has enough flowers to fill an area of space equal to 120 ft^2. If x=2, Determine if Polly will have enough flowers to fill all her flower gardens. Justify your answer. (Hint: use the polynomial expression from 2c, not after Iris and Sonny combine their gardens).

Task Implementation (After)

Connecting Student Responses (From Anticipating Student Response Chart) and Closure of the Task:

- Connect different students' responses and connect the responses to the key mathematical ideas to bring closure to the task. Compare and contrast student answers to determine what strategies may still need to be identified.
- Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion. Ensure each student has an opportunity to share within individual groups.
- Identify and discuss important vocabulary words to help make connections to the task.

Teacher Reflection About Student Learning:

- What process did students go through to determine what strategy and operations to use? Did this lead them to the correct answer?
- How will the evidence provided through student work inform further instruction?
- Do students understand the vocabulary that supports their knowledge of the SOL standard?
- Are students able to explain their work in writing, verbally, or orally?

Planning for Mathematical Discourse

Mathematical Task: Flower Gardens Content Standards: A.2a,b

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: Student is unable to start question 1.	• Part a: Ask students, what shapes is represented for each neighbor's garden? • Part b: Ask students, what important information can be highlighted in the question to determine which method to use? How can the method used for a be useful for b?	• How would the expression for the total area change if the lengths of the garden change? • How would the expression for the total area change if the shapes of the garden change?		
Anticipated Student Response: Question 2c, students fail to understand how to calculate the new measurement.	• Ask students to review important vocabulary from the problem to determine which steps to use. • Have students create a representation of each garden to determine what steps need to be taken.	• If we were to add an additional garden area composed of a square and a semicircle, what information would we need to find the area (remind students to consider how to find the area of a circle)?		

Anticipated Student Response/Strategy *Provide examples of possible correct student responses along with examples of student errors/misconceptions*	**Assessing Questions – Teacher Stays to Hear Response** *Teacher questioning that allows student to explain and clarify thinking*	**Advancing Questions – Teacher Poses Question and Walks Away** *Teacher questioning that moves thinking forward*	**List of Students Providing Response** *Who? Which students used this strategy?*	**Discussion Order - sequencing student responses** • *Based on the actual student responses, sequence and select particular students to present their mathematical work during class discussion* • *Connect different students' responses and connect the responses to the key mathematical ideas.* • *Consider ways to ensure that each student will have an equitable opportunity to share his/her thinking during task discussion*
Anticipated Student Response: Students is unable to start 4a.	• Ask students what expression would need to halved? • What operation(s) could be used to find half?	• Have students identify a second way this problem can be done. • What would the area of space be if it were reduced by ¼?		

NAME _____ DATE_____

Flower Gardens

1. Polly Petals runs a small business creating flower gardens for people in her community. As spring approaches, the following customers have provided the dimensions of different flower gardens each would like to have created.

   - Rose Bush has a rectangular space with lengths of $3x + 1$ and $2x + 7$.
   - Iris Orchid has a rectangular space with lengths $4x + 2$ and $x + 5$.
   - Sonny Flower has a square space with lengths of $4x + 2$.

   a. Sketch the shape of each design to represent the space available for the flower gardens of each customer (label the lengths). Determine the area of space available for each customer. Show work to justify each answer.

   b. Determine the total area of space Polly must work with for all her customers.

2. Rose has determined that she has another rectangular space in the front of her garage where she would like to add a flower garden with the same measurements as the first space.

   a. Determine the total area of space that Rose now has for both of her flower gardens.

   b. With the inclusion of Rose's second flower garden, determine the total area of all of the spaces that Polly must work with for all her customers.

   c. Iris Orchid has later determined that she does not want to use her entire rectangular space and instead will use a square shaped space with similar sides of $4x + 2$. Determine her new area of space as well as the total space that Polly now must work with.

3. Iris and Sonny are neighbors and have decided to combine their flower gardens.

   a. Sketch a picture to represent what Iris and Sonny´s garden will look like.

   b. Determine the area of space that is now needed for their combined garden. Show work to justify your solution.

4. Iris has decided to change the size of flower garden.
   a. Iris decides to cut the side length $4x + 2$ of her rectangular space in half, determine her new area of space. Sketch a visual representation of the math used to determine your answer. Write a polynomial expression to justify your answer.
   b. What polynomial expression would result if Iris had enough to double the side length $4x + 2$ of her flower garden?

Rich Mathematical Task Rubric

	Advanced	Proficient	Developing	Emerging
Mathematical Understanding	Proficient Plus: ● Uses relationships among mathematical concepts or makes mathematical generalizations	● Demonstrates an understanding of concepts and skills associated with task ● Applies mathematical concepts and skills which lead to a valid and correct solution	● Demonstrates a partial understanding of concepts and skills associated with task ● Applies mathematical concepts and skills which lead to an incomplete or incorrect solution	● Demonstrates no understanding of concepts and skills associated with task ● Applies limited mathematical concepts and skills to find a solution or provides no solution
Problem Solving	Proficient Plus: ● Problem solving strategy is well developed or efficient	● Problem solving strategy displays an understanding of the underlying mathematical concept ● Produces a solution relevant to the problem and confirms the reasonableness of the solution	● Problem solving strategy displays a limited understanding of the underlying mathematical concept ● Produces a solution relevant to the problem but does not confirm the reasonableness of the solution	● A problem-solving strategy is not evident ● Does not produce a solution that is relevant to the problem
Communication and Reasoning	Proficient Plus: ● Reasoning or justification is comprehensive ● Consistently uses precise mathematical language to communicate thinking	● Demonstrates reasoning and/or justifies solution steps ● Supports arguments and claims with evidence ● Uses mathematical language to communicate thinking	● Reasoning or justification of solution steps is limited or contains misconceptions ● Provides limited or inconsistent evidence to support arguments and claims ● Uses limited mathematical language to partially communicate thinking	● Provides no correct reasoning or justification ● Does not provide evidence to support arguments and claims ● Uses no mathematical language to communicate thinking
Representations and Connections	Proficient Plus: ● Uses representations to analyze relationships and extend thinking ● Uses mathematical connections to extend the solution to other mathematics or to deepen understanding	● Uses a representation or multiple representations, with accurate labels, to explore and model the problem ● Makes a mathematical connection that is relevant to the context of the problem	● Uses an incomplete or limited representation to model the problem ● Makes a partial mathematical connection or the connection is not relevant to the context of the problem	● Uses no representation or uses a representation that does not model the problem ● Makes no mathematical connections