Impact on Student Learning

Submitted by:
Anastashia Pelletier

Grade 7 & 8 Algebra
Farmwell Station Middle School
Loudoun County Public Schools

Clinical Faculty: Mary Hamdan
University Supervisor: Roger Dallek

Spring 2025

Educational Context

For my teaching experience, I initially hoped to be placed in a high school setting, given my background working with older students in Algebra and Trigonometry. However, teaching Pre-Algebra and Algebra to a mix of 7th and 8th graders has proven to be an incredibly eye-opening and rewarding experience. Over the past five weeks, I've had the opportunity to get to know each student more personally, which has greatly informed and improved my lesson planning.

Since I'm responsible for teaching two different subjects, I chose to focus my reflections on my two Algebra classes. These classes share very similar behavioral patterns and academic needs, which made it easier to plan and manage instruction. One class has 18 students, and the other has 19, allowing for a manageable classroom dynamic where I can provide more individualized support. Additionally, the school where I was placed emphasizes consistency across classrooms, requiring that all teachers on the math CLT (Collaborative Learning Team) teach the same material in similar way. While this approach limits flexibility in terms of pacing and content, it does ensure equity in instruction across all sections.

The classroom itself is spacious and equipped with 18 desks, arranged in pods of four to encourage collaboration and team learning. A set of three additional desks is placed at the back of the room, which serves multiple purposes: accommodating students who need a quieter space, providing a spot for brief pull-asides during class, or supporting students from other blocks who drop in for extra help. The room is equipped with a Smart Board, and each student has access to their own Chromebook, which the teacher can monitor and manage using the Lightspeed app. There are also three chairs near the teacher's desk to facilitate one-on-one support during guided practice.

Neither of my Algebra classes includes students with 504 plans or IEPs, and English Language Learners are placed in a separate class. Additionally, there are no students in these classes with identified behavioral or physical disabilities. Most disruptions tend to come from students wanting to socialize with

peers rather than from serious behavioral issues. To address this, I've used a mix of incentives and consequences. Positive reinforcement strategies include allowing students to work with friends after completing their assignments or awarding school-issued reward tickets to students who stay on task. When needed, I've used consequences such as moving students to the back of the room or to the teacher's desk—locations where they can be more easily monitored by me or my clinical faculty member. These strategies have been effective in minimizing off-task behavior.

A few students have required additional academic and behavioral support. In some cases, their classroom behavior directly impacted their ability to learn, prompting further interventions. I've had the opportunity to attend and contribute to three parent-teacher conferences focused on these students. The strategies discussed and implemented during these meetings have already led to noticeable improvements in both behavior and academic performance, which has been encouraging to witness firsthand.

Assessment of the Instructional Environment

Directions

The Assessment of the Instructional Environment is completed during the first week of student teaching. The purpose of this assessment is to provide the teacher candidates with contextual information for planning and implementing effective instruction. The objective is to gather information about individual learners in the classroom, their diverse learning needs, the classroom organization, possible interruptions/disruptions to the learning environment, and available educational resources. Teacher candidates are to complete the assessment form and narrative statement and discuss the implications for instruction with the university supervisor during the first visit.

Teacher Candidate Name_____Anastashia Pelletier_____

University Supervisor_____Roger Dallek_____

Clinical Faculty _____Mary Hamdan_____

School /Division/district_____Farmwell Station Middle School / Loudoun County Public School_____

Subject_____Algebra_____ **Grade**_____7th and 8th_____ **Semester**_____Spr 2025_____

Date	***General Information***
7th and 8th	Grade Level (s)
12-14	Ages
Number	***Student Information***
37	Total Typically Present
18	Male
19	Female
	Total Race
3	Hispanic
2	Asian
4	African American
0	Native American
0	Hawaiian/ Pacific Islander
28	White
0	Two or more races
0	Total English Language Learners (ELL)
0	ELL Receiving Services
0	ELL Not Receiving Services
0	Learners with 504 Plans
0	Learners Involved in Child Study Process
0	Learners Involved in Eligibility Process
0	Learners Identified as Eligible for Special Education Services
0	Learners with Learning Disabilities
0	Learners with Emotional and Behavioral Disabilities
0	Learners with Autism Spectrum Disorder
0	Learners with Other Health Impairments
0	Learners with Physical Disabilities
0	Learners with Speech and Language Disabilities

0	Learners with other disabilities (please identify)
0	Total Learners in Pull-out or Supplementary Programs
	Specify Programs in your narrative statement
5	Learners who are unusually demanding of time or energy not identified in other categories (e.g., disruptive, withdrawn, dependent, etc)
5	Learners with excessive absences and/or tardiness
Rating	***Levels of Diversity by Category (Rating L=Low, M=Medium, H=High)***
L ○ M ○ H ○ H	Ages
L ○ M ○ H ○ M	Languages
L ○ M ○ H ○ L	Developmental Levels
L ○ M ◉ H ○ M	Cultures
Check one	***Teaching Interruptions***
✔	Few Interruptions
	Some Interruptions (describe in narrative)
	Many Interruptions (describe in narrative)
Check one	***Room Organization***
✔	Well Organized
	Adequately Organized
	Poorly Organized
Check One	***Resources: Equipment and Supplies***
✔	Well Equipped and Supplied
	Adequately Equipped and Supplied
	Poorly Equipped and Supplied
Time	***Time On Task***
1 hr to 1 hr and 10 mins	Time spent each day on instruction
Less than 5 mins	Time spent each day on transitions
5 mins to 10 mins	Time spent each day on “non-academic activities” (free time, waiting, trying to start class or redirect inappropriate behavior, etc.)

Narrative

In both of my Algebra classes, none of the students currently have accommodations for learning, behavioral, or physical disabilities. During instruction time, students tend to stay focused and engaged with the material. However, I’ve noticed that most disruptions occur during guided practice, with an average of two to three interruptions per class, usually caused by off-task conversations. To address this, I plan to set clear behavioral expectations and incorporate positive reinforcement strategies to promote student engagement. Possible incentives include allowing students to collaborate with their peers, handing out small rewards like Jolly Ranchers, or distributing school prize tickets.

Pre-Test / Post Test

Due to strict assessment and assignment guidelines at my placement, I administered the pre-test following a review session for the unit's prior major summative. The post-test was given as a warm-up activity during the class immediately after the major summative on the laws of exponents and radicals. Additionally, I was required to choose an assessment from a pre-approved bank of assignments maintained by the CLT on a shared Google Drive. With support from my clinical faculty member, I reviewed multiple options and carefully selected the one that best aligned with the content I wanted to assess.

The assessment consisted of six questions, each requiring students to show their work and clearly identify their final answers. Calculators were not permitted, and students were instructed to treat the assignment as if it were a major summative. To ensure genuine responses, I did not inform students of the pre-test's purpose ahead of time. However, after the post-test, some students expressed concern about how it might impact their grades. I took this opportunity to explain the purpose of the assessment and reassure them that it would not negatively affect their overall performance.

This assessment was aligned with Virginia Math SOL A.EO.3, which requires students to derive and apply the laws of exponents. For the objectives, students were expected *to explore patterns to derive exponent rules involving products, quotients, and powers of the same base (A.EO.3 a)*. They were also expected to *simplify expressions involving multiple variables and ratios of monomials with integer exponents using appropriate exponent laws (A.EO.3 a)*.

When grading the pre-test and post-test, I had to determine whether partial credit would be awarded for student responses. This decision directly impacted how many points each question would be worth. Given that students had been taught to use calculators for operations such as multiplication, division, and exponentiation, I decided it would be appropriate to assign two points per question.

For questions 1, 2, 3, 4, and 6, I allocated one point for correctly simplifying the numerical coefficient and one point for accurately applying exponent rules to the variables. In question 5, students could earn one point for correctly applying the quotient rule and another for using the zero exponent rule appropriately. This approach allowed me to assess whether errors were conceptual misunderstandings of exponent rules or simply computational mistakes involving coefficients.

****Please note that both the Pre-test and the Post Test are exactly the same but given about 3 weeks apart****

Question 1 targets the product of powers rule. Students are expected to identify like variables and combine their exponents by adding, while also multiplying the coefficients. According to objectives, students must simplify expressions using exponent rules. This problem checks if they have built fluency with combining terms in multi-variable expressions.

Question 2 applies the power of a power rule and simplify each group before multiplying. Students must be able also multiply coefficients and apply exponents across variables. This aligns with the given objectives, which requires using exponent properties to simplify expressions. This question demonstrates if the students can see how multiple rules work together.

Question 3 focuses on the quotient of powers rule. Students simplify coefficients and subtract exponents of like bases in the numerator and denominator. The objectives expect students to simplify algebraic fractions. This question shows their strength with negative exponents and proper simplification.

Question 4 is a complex expression that combines several exponent rules. Students must simplify powers, apply division of like terms, and then multiply. It supports the objectives by requiring multiple steps and careful reasoning. This problem helps evaluate whether students can apply exponent laws in sequence.

Question 5 concentrates on simplifying by using the quotient rule and apply the zero exponent rule. This problem tests a student’s understanding of how 0 exponents behave. This supports objectives since students must correctly interpret exponent rules in a combined expression.

Question 6 assesses how to handle negative exponents with a fractional base. They must flip the expression, then apply the exponent to all parts. Aligned with the objectives, this checks students' precision and understanding of how exponents affect structure in algebraic expressions.

Post Test

Name:

Simplify the following Exponential Functions ☺

1. $4v^4 \cdot 6u^3v^5 \cdot 9uv^7$

2. $(-4a^3c^5)^2 \cdot (2ab^6c^2)^3$

3. $\frac{54x^6y^4z^{10}}{6x^4y^6z^7}$

4. $\frac{(d^4e^2)^3}{2d^6f^2} \cdot \frac{10e^3f^4}{(e^2d^2)^2}$

5. $(\frac{x^{10}}{x^6})^2 \cdot (\frac{x^{78}}{x^{100}})^0$

6. $(\frac{2x^2}{y^3})^{-3}$

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Pretest

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Analysis of Pre-Test

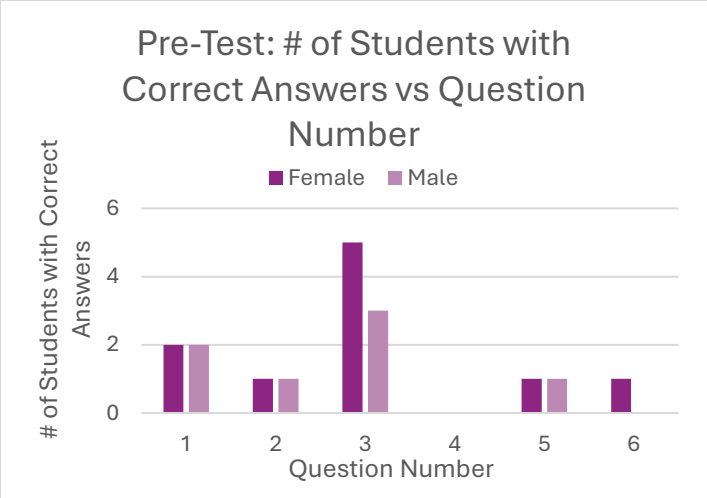
Pre-Test Analysis Introduction

The pre-test administered focused on six content-specific questions targeting the laws of exponents, including product, quotient, power, zero, and negative exponent rules. Analyzing student responses to each question provided valuable insight into class-wide understanding and subgroup trends. For subgroup trends, there an insignificant difference between the race and age of the students, but there was a noticeable difference in the gender of the student. A breakdown of performance by gender, average scores, and question-specific accuracy revealed that while many students showed strength in applying basic rules like the product and quotient of powers, but others struggled with more complex applications, such as expressions with negative exponents or nested powers. These findings will guide future instructional planning and targeted support.

Analysis 1: Question-by-Question Performance by Gender

	Total	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6
Female	9	2	1	5	0	1	1
Male	7	2	1	3	0	1	0

This first analysis details how many students answered each of the six pre-test questions correctly, disaggregated by gender. This data reveals patterns of item-specific understanding and highlights conceptual strengths and weaknesses. The most striking finding is that Question 4 received zero correct responses from both male and female students, indicating a likely instructional gap. Female students generally had higher numbers of correct responses across the board, particularly on Questions 3, 5, and 6. The greatest number of correct responses occurred on Question 3, suggesting that students had some prior knowledge or comfort with that content.

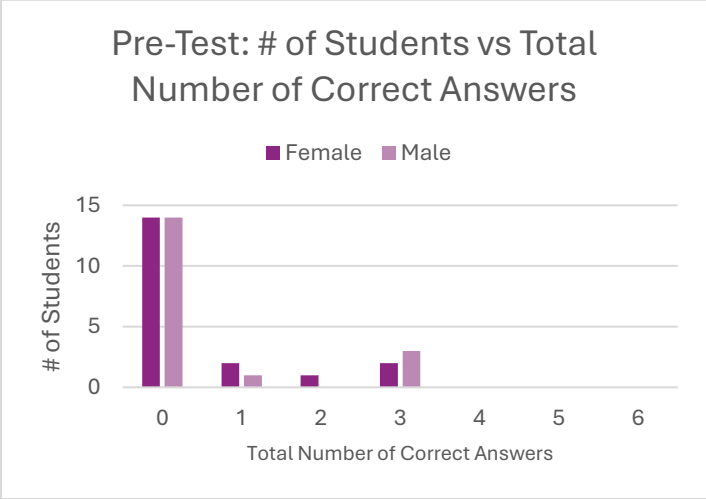


	Female	*Male*
Median	1.00	1.00
Mode	1.00	1.00
Range	5.00	3.00
Minimum	0.00	0.00
Maximum	5.00	3.00
Mean	1.67	1.17
Standard Deviation	1.75	1.17
Variance	3.07	1.37

Analysis 2: Distribution of the Number of Fully Correct Questions by Gender

	0	1	2	3	4	5	6
Female	14	2	1	2	0	0	0
Male	14	1	0	3	0	0	0

This analysis presents how many students scored from 0 to 6 correct answers on the pre-test. Most students scored between 0 and 3 questions correct, but none of the students answered all six questions correctly. This wide distribution indicates significant variance in prior knowledge and a strong need for differentiated instruction. Students scoring at the lower end may benefit from small group instruction or targeted review sessions, while those scoring at the higher end could be provided with enrichment tasks to deepen their understanding.

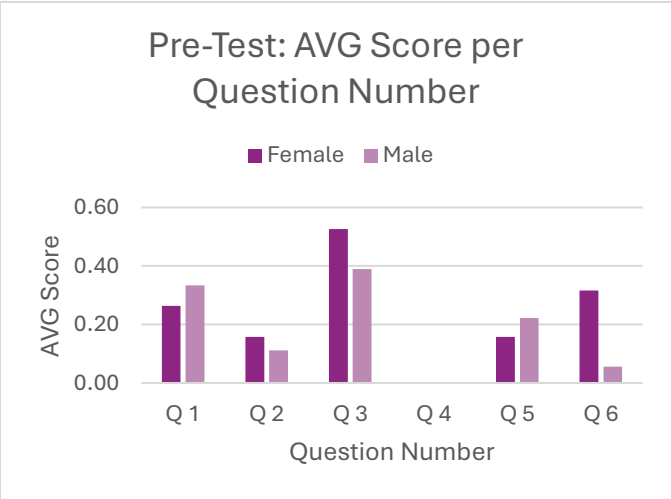


Analysis 3: Average Scores by Question and Grade Percentage by Gender

	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6
Female	0.26	0.16	0.53	0.00	0.16	0.32
Male	0.33	0.11	0.39	0.00	0.22	0.06

	Pre: AVG Grade %
Female	12%
Male	10%

Analysis 3 gives the average score per question and average grade percentage for each gender. This allows for more nuanced comparisons by normalizing student success on a per-question basis. Again, female students scored higher on average across most questions. The average score for both genders peaked on Question 3, while Question 4 again saw zero average scores, confirming the need for focusing on complex applications involving the laws of exponents. These averages are useful for identifying where instruction will be the most effective or where misconceptions may form.



	Female	*Male*
Median	0.21	0.17
Mode	0.16	N/A
Range	5.00	3.00
Minimum	0.00	0.00
Maximum	5.00	3.00
Mean	0.24	0.19
Standard Deviation	0.18	0.16
Variance	0.03	0.02

Pre-Test Analysis Conclusion

Together, these tables and graphs provide a clear picture of where instructional time and support are most needed. Questions with universally low performance, like Question 4, should be taught with visual supports or alternative explanations. Small-group instruction may help address the range in student readiness revealed in Analysis 2. Lastly, gender trends suggest a need for ongoing monitoring to ensure equitable access to support and challenge.

Planning and Instructions

Unit Plan Overview

Teacher Candidate:	Anastashia Pelletier	**Date Taught:**	March 6th – March 17th
Cooperating Teacher:	Mary Hamdan	**School/District:**	Farmwell Station Middle School / Loudoun County Public Schools.
Grade:	7th and 8th	**Field Supervisor:**	Roger Dallek
Unit/Subject:	Algebra: Laws of Exponents and Radicals		
Lesson Title/Focus:	All Laws of Exponents (Product, Quotient, and Power Rules, Negative Exponent Rule, and Zero Exponent Rule). Fractional Exponents and Radicals		

Content Knowledge:

The laws of exponents are a set of fundamental rules that govern how to simplify expressions involving exponents. These rules are essential for working with algebraic expressions and equations. The product of powers rule states that when multiplying terms with the same base, you add the exponents. The quotient of powers rule requires subtracting the exponents when dividing terms with the same base. The power of a power rule dictates that when raising an exponent to another power, you multiply the exponents. Additionally, the zero exponent rule specifies that any nonzero number raised to the power of zero equals one, and the negative exponent rule teaches that a negative exponent indicates the reciprocal of the base raised to the positive exponent. A deep understanding of these laws allows students to simplify complex expressions, solve equations, and lay the groundwork for more advanced topics in algebra and higher mathematics.

Learner Differences:

This lesson was developed based on my research into how students learn and the data I gathered from their previous work. I found that students often struggle with abstract concepts like the laws of exponents, especially when they first encounter them. To help meet the needs of my students, I included different learning strategies, like using visual aids and interactive activities, which can make the material more accessible to everyone. I know that some students might have difficulty understanding the rules right away, so I broke the content into smaller, more manageable steps, and gave them plenty of practice. Overall, I aimed to create a lesson that would help all students feel confident in their learning and engaged with the topic.

Outcomes/Goals:

As a result of this lesson, students will be expected to understand and apply the laws of exponents, including the product, quotient, and power rule, zero exponent, and negative exponent rules. They will demonstrate their ability to simplify algebraic expressions by combining like terms, handling coefficients, and applying exponent rules to both monomial and multivariable expressions. Additionally, students will be able to solve problems involving exponents, such as simplifying complex expressions and working with fractional or negative exponents.

Standards:

Virginia Math **SOL A.EO.3** The student will derive and apply the laws of exponents.

Students will demonstrate the following Knowledge and Skills:

a) *Derive the laws of exponents through explorations of patterns, to include products, quotients, and powers of bases*.

b) *Simplify multivariable expressions and ratios of monomial expressions in which the exponents are integers, using the laws of exponents.*

Resources and Materials:

- Physical Resources:
  - Student notebooks
  - Structured notes pages
  - Graphic organizers pages
  - Warm-up half-sheets
  - Mixed-practice worksheets
  - Pencils and highlighters
  - Chromebook
  - Glue sticks

- Digital Resources:
  - Desmos Activities
  - Discovering the Laws of Exponents
  - Negative Exponents Activity
  - Edia Assignments
  - Simplify Expressions with Negative Exponents
  - YouTube Videos
  - Laws of Exponents
  - Dividing Monomials
  - Schoology

Technology:

Technology enhances both the design and delivery of my lessons and actively engages students in learning. Tools like Desmos and Edia allow students to interact with exponent rules through visual, self-paced activities that provide instant feedback. I use YouTube videos (such as The Math Dude) to reinforce concepts with clear, student-friendly explanations, supporting both visual and auditory learners. My Promethean Board is used to model problems and guide class discussions, making instruction more interactive. Using a variety of technical resources will help me differentiate instruction, monitor progress in real time, and create a more engaging, student-centered classroom where learners can explore, reflect, and grow.

Student technology needs include:

- Chromebooks
- Headphones
- Schoology access for assignments

Teacher technology includes:

- Promethean Board
- Laptop/Chromebook
- Desmos and Edia teacher dashboards
- Smartboard presentations

Learning Environment:

To support both individual and collaborative learning, I structure my classroom to encourage teamwork while also providing space for focused, independent work. Students are seated in pods of four, which promotes peer interaction and group problem-solving during guided practice. I often use structured activities that allow students to explain their thinking to one another, reinforcing their understanding through discussion. For individual support, I offer one-on-one help at the teacher desk during work time and make use of tools like Lightspeed to monitor student progress on their Chromebooks. Positive interaction is encouraged through the use of incentives, such as allowing students to work with a preferred partner or earning tickets for class rewards. These strategies create a respectful and supportive environment where students feel comfortable participating and staying engaged with the content.

Introduction/Activating Strategies:

To engage my students and spark interest in the lesson, I always begin with a quick, purposeful warm-up that connects to what we've previously learned. These warm-ups are usually designed to activate prior knowledge—whether it’s reviewing the product or quotient rule or practicing order of operations—so students feel confident as we transition into new content. I launch each lesson with a few open-ended or thought-provoking questions that help students make connections between familiar concepts and the day’s objective. For example, before introducing negative exponents, I might ask, “What happens when the exponent in the denominator is larger than the one in the numerator?” or “What do you get when you subtract a larger number from a smaller one?” These types of questions get students thinking critically and

allow them to share their ideas, which naturally leads us into the new material. I also include visuals, quick peer discussions, and movement when possible to keep the energy up and help all learners engage from the very beginning.

Instructional Strategies:

In this unit, I've designed a variety of learning activities to help my students develop a strong understanding of the laws of exponents, including the product, quotient, power, and negative exponent rules. Each lesson begins with a warm-up that activates prior knowledge and helps students make connections to the new content. I then guide them through direct instruction using structured notes and modeled examples, where I break down the steps and invite students to think critically through probing questions. We engage in both guided and independent practice, so students have time to apply the rules on their own while still having support. I incorporate collaborative group work and discussions to encourage peer learning and mathematical discourse. To keep students engaged and support different learning needs, I also use technology such as Desmos and Edia, which provide interactive practice and allow me to monitor progress in real-time. Visual supports like graphic organizers help students organize their thinking and connect the different exponent rules. I make sure to close each lesson with a reflection or check-for-understanding activity to help students solidify what they've learned and set the stage for the next day's objective. These activities not only prepare them for success on the SOL but also help build their confidence in tackling complex algebraic expressions.

Closure:

At the end of each lesson, I intentionally bring the class back together to reflect on what we've learned and to reinforce the key concepts from the day. I usually do this by asking open-ended, reflective questions like, "What's one thing you learned today about exponents that you didn't know before?" or "How does today's rule connect to what we've already learned?" These questions give students the opportunity to verbalize their understanding, identify any confusion, and hear how their peers are thinking about the content. Sometimes we'll have a brief class discussion, and other times I'll ask students to write a quick reflection or complete an exit ticket so I can get a sense of how well they've grasped the material. I also use this time to review any common misconceptions I noticed during the lesson and to preview what we'll be learning next. For example, after working on the power rule, I might introduce a question that leads into negative exponents for the following day. This closure routine not only reinforces student learning but also gives them a sense of accomplishment and continuity.

Differentiation:

To meet the needs of my diverse group of learners, I plan and adjust my instruction with flexibility, scaffolding, and multiple modes of engagement. I incorporate a variety of strategies during each lesson—starting with clear modeling and guided examples, followed by small group discussions and structured independent practice. I constantly monitor student understanding by circulating the room, checking for accuracy and misconceptions, and adjusting my pacing or grouping as needed. For students who need extra support, I provide one-on-one assistance, break down multi-step problems into smaller parts, and offer visual aids like graphic organizers to help

structure their thinking. Technology plays a big role in differentiation as well. Tools like Desmos and Edia allow students to engage with the content at their own pace and in an interactive format, while also giving me real-time insight into their progress. These platforms are especially helpful for visual and auditory learners, and they allow me to assign targeted follow-up activities based on individual needs. I also incorporate videos, such as the Math Dude tutorials, to reinforce key concepts in a more accessible way. By layering direct instruction, peer collaboration, and tech-based exploration, I can ensure all students—from those who need extra reinforcement to those ready for a challenge—have opportunities to access, process, and master the content in meaningful ways.

Assessment:

To assess student understanding of the laws of exponents, I use a balanced mix of formative and summative assessments embedded throughout the unit. Formatively, I check for understanding through daily warm-ups, guided practice in student notebooks, exit tickets, and class discussions. Interactive platforms like Desmos and Edia allow me to monitor progress in real time and provide immediate feedback or reteaching when needed.

For summative assessment, students complete a pre-test, task card sets, mixed-practice assignments, a minor summative, and a post test covering all exponent rules, including applications in geometry. These tools allow me to evaluate both procedural fluency and critical thinking in a way that aligns with the standards and supports student growth.

Reflection:

To evaluate my teaching practice, I reflect on student engagement, assessment data, and areas of struggle observed during lessons. In the exponent unit, students showed confidence with individual rules but often struggled when multiple rules were combined in a single expression, especially with negative exponents. I use online assignments, such as Desmos and Edia, to pinpoint misconceptions and determine where reteaching is needed. To strengthen the lesson, I plan to scaffold more clearly, provide visual reference tools for each rule, and offer more guided practice before moving into independent or mixed-rule tasks. Increasing opportunities for peer discussion will also help students clarify their thinking.

The lessons support culturally sustaining pedagogy through collaborative learning, flexible instructional methods, and inclusive content. Using interactive platforms and offering multiple ways to engage (visuals, videos, hands-on notes) allows me to meet diverse learning needs. Including historical context, such as the mathematician spotlight on Robert Recorde, adds cultural depth, and I plan to continue expanding this by incorporating more real-world and culturally relevant examples that reflect my students' lived experiences and identities.

Title: Raising the Power! **Grade level/content area: 8th Grade Algebra**

Author(s):
Anastashia Pelletier

Date lesson will be taught: March 6th/7th

Source of the lesson:
Teacher modified from school's CLT Plans

CONCEPT STATEMENT
In this lesson, students will explore numerical patterns to uncover the fundamental laws of exponents, including products and quotients of bases. Through guided discovery, they will derive these rules and apply them to simplify multivariable expressions and ratios of monomials with integer exponents. Robert Recorde, a 16th-century mathematician known for introducing the equals sign (=), contributed to the foundation of modern algebra, including exponent notation. By recognizing and applying these exponent properties, students will strengthen their algebraic reasoning and problem-solving skills.

Important Vocabulary:
Exponent – The number that indicates how many times the base is multiplied by itself.
Base – The number being raised to a power.
Power – An expression that represents repeated multiplication of the same factor.
Product of Powers Property – The rule stating that when multiplying like bases, add the exponents.
Quotient of Powers Property – The rule stating that when dividing like bases, subtract the exponents.
Monomial – A single term consisting of a coefficient, variables, and exponents.

LESSON OBJECTIVES
Students will be able to… define the different laws of exponents, including the product and quotient rules, through pattern exploration and apply these laws to simplify expressions with integer exponents, including multivariable expressions and ratios of monomials.

VIRGINIA SOL OBJECTIVE(s) ADDRESSED
A.EO.3 The student will derive and apply the laws of exponents.

MATERIALS NEEDED (Resources, supplies, and handouts)
Highlighter, Pencils, Chromebook, glue sticks, and notebook
'Mathematician of the Unit: Robert Recorde' Slides
'Laws of Exponents Exploration' notes and 'Exponents and Radicals' note bundle
'Laws of Exponents' and 'Dividing Monomials' videos by The Math Dude
'Discovering the Laws of Exponents' Desmos
'HW 1: Product Rule' worksheet and 'HW 3: Quotient Rule' worksheet

SAFETY CONSIDERATIONS
Students will be instructed to use all materials for their intended use.

ENGAGEMENT	Estimated Time: 10 minutes
Teacher and Student Activity	**Probing Questions**
Students will glue in 'Laws of Exponents Exploration' notes and 'Exponents and Radicals' note bundle.	
Teacher will display the 'Mathematician of the Unit: Robert Recorde' slides on to the smartboard. Teacher will go over the slides, explain that Recorde wanted to allow those that were not highly educated to easily relate to math concepts.	
Students will work in their pods and discuss the 3 questions presented on the board. After about 5 mins, a representative of each group will share with the class on what the group discussed.	• Why do you think mathematicians create shortcuts or rules like the laws of exponents? • How would math be different if we had no symbols or simplifications? • Can you think of a real-world example where simplifying a process makes things more efficient?
Teacher will introduce today's topic of Laws of Exponents and hand out highlights for exploration.	

EXPLORATION	Estimated Time: 15 minutes
Teacher and Student Activity	**Probing Questions**
For 10 minutes and in their pods, students will work together to complete the Product Rule and Quotient Rule pages of their 'Laws of Exponents Explore" notes. Students will use the highlighter to color in the circles that they create for the various examples that they see.	
After 10 mins or when most of the pods have finished their work, students will share what pattern have they noticed when looking at the first column and the last column of both pages.	• What operations do we see involved in using exponents? • What other operations involve repeating a different operation?

EXPLANATION	Estimated Time: 30 minutes
Teacher and Student Activity	**Probing Questions**
Teacher will play 'Laws of Exponents' video by The Math Dude. After the video, teacher will ask students 'What did you notice and what did you wonder?' Students will be chosen at random to give their response.	
Teacher will then have the students turn to the first page of their 'Exponents and Radicals' notes. Teacher will define what a monomial is.	• What is an example of a monomial?

Teacher will explain that when multiplying monomials, one must add the exponents. Teacher will fill in the first example. Then together with the students, they will work on simplifying problems 17, 18, and 19.	• Why do we add exponents when multiplying monomials instead of multiplying them? • How does the product rule relate to the idea of repeated multiplication? • What would happen if we accidentally multiplied the exponents instead of adding them? Can you give an example?
Teacher will remind students that if there are coefficients, then one must multiply the coefficients and then simplify the variables using the product rule to the exponents. Together, Teacher and students will go over example problems 20, 23, 24, 26, 27, 32 and 34.	• How does multiplying coefficients differ from working with exponents? Why don't we add coefficients like we do exponents? • Can you explain why the product rule only applies when the bases are the same? What happens if the bases are different?
Teacher will then play 'Dividing Monomials' video by The Math Dude. Again teacher will ask students 'What did the notice and what did they wonder?' A few random students will be chosen to give their responses.	
Teacher will tell students to turn to page 2 in their 'Exponent and Radiants' note bundle, and teacher will explain that when dividing monomials, one must subtract the exponents. Teacher will fill in the first example. Then together with the students, they will work on simplifying problems 1, 3, 4, and 6.	• Why do you think we subtract exponents instead of dividing them when working with the quotient rule? • How is dividing monomials like multiplying monomials? How is it different? • What would happen if we added the exponents instead of subtracting them when dividing?
Just like the product rule, teacher will remind students that if there are coefficients, then one must divide the coefficients and then simplify the variables using the quotient rule to the exponents. Together, Teacher and students will go over example problems 7, 9, 10, and 11.	• Why does the coefficient follow normal division rules, while the exponents follow the quotient rule?
Teacher will then instruct students to take out their Chromebook, where students will get to review what we have just talked about, how it applies to the real world and an introduction to the power rule of exponents.	

ELABORATION	**Estimated Time: 15 minutes**
Teacher and Student Activity	**Probing Questions**
On their Chromebooks, students will work to start the 'Discovering the Laws of Exponents'	

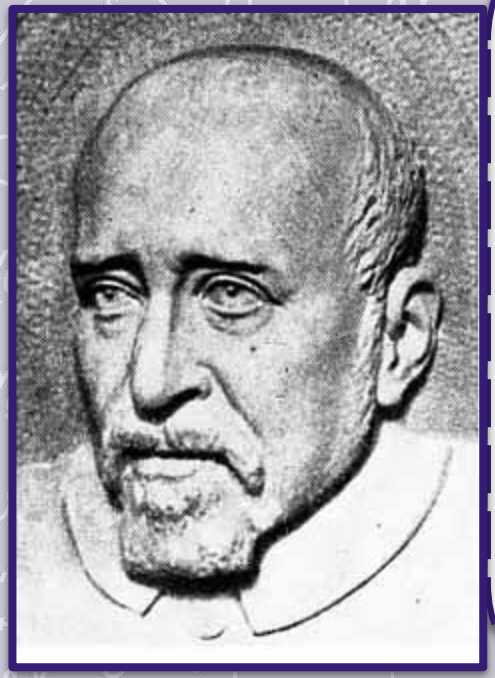
Desmos. Students will be given 10 mins to work on their Desmos.	
Teacher will observe students' progress on the Desmos teacher app. If a student seems like they are struggling, then the teacher will have a few moments of one-on-one help to clarify any misconceptions.	
After 10 mins, teacher will ask students questions based on what they read about in the Desmos.	• What did we observe about the applications of the laws of exponents? • What other examples could you use the product and quotient rules in someone's everyday life? • What differences and similarities did you notice about the product rule and the power rule?

EVALUATION	**Estimated Time: 10 minutes**
Teacher and Student Activity	**Probing Questions**
Teacher will then hand out homework assignments: 'HW 1: Product Rule' and 'HW 3: Quotient Rule'. Students will have 8 mins to work on problems 16 and 19 from HW1, and problems 1 and 7 from HW 3.	
Once student is done, student will check in with the teacher and receive feedback on their work. Any additional time, student will begin working on the odds from the two HW sheets, starting at problem 13 for HW 1, or work on completing the Desmos.	

Mathematician of the Unit

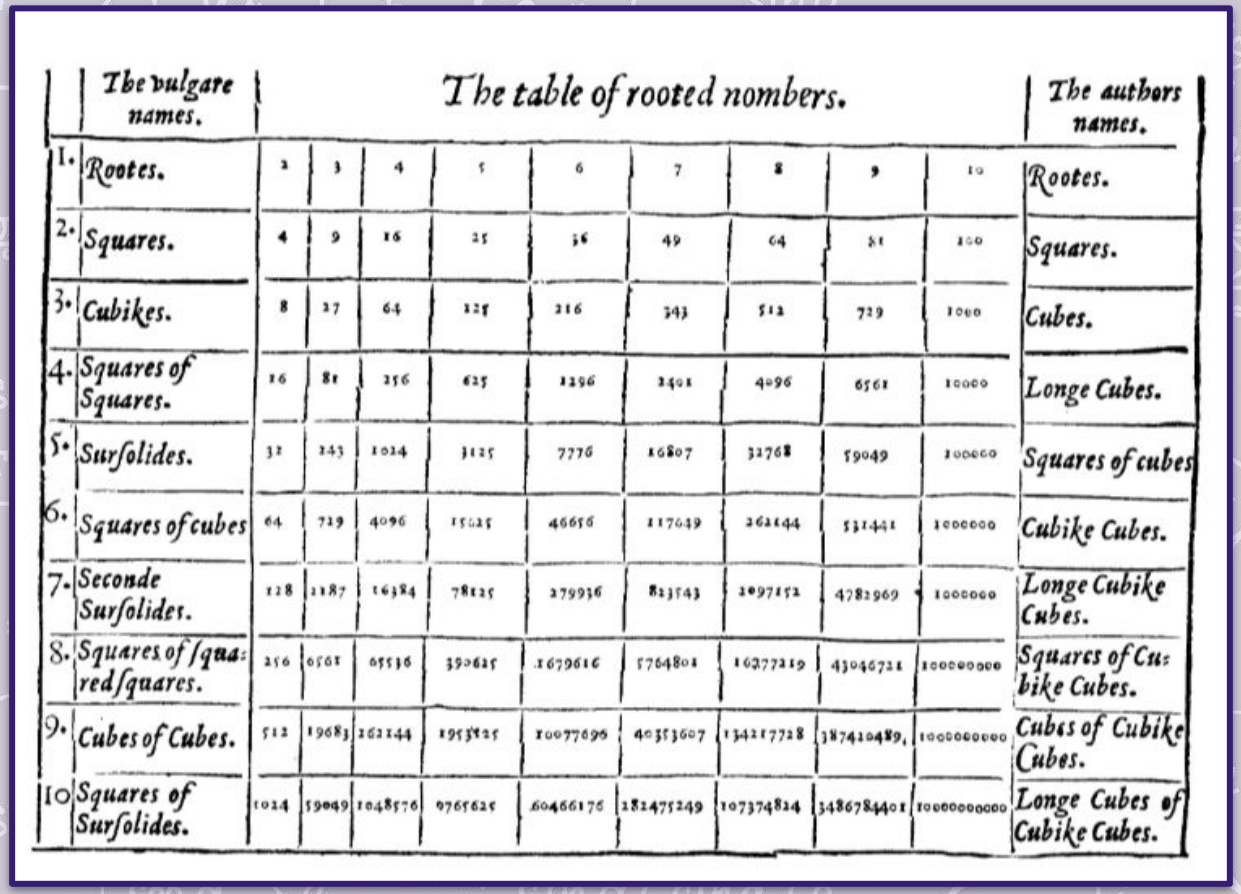
Robert Recorde

Robert Recorde



- Robert Recorde was the inventor of of the equal symbol that is used in modern day mathematics.
- He wanted mathematics to be easier to understand for the uneducated at the time.
- Recorde faced professional conflicts, notably with Sir William Herbert, leading to his imprisonment for debt, where he died in 1558.
- Recorde used the notations for square and cube to make a more symbolic representation. To the side is a picture from his book about the comparison.

Robert Recorde



	The vulgare names.	The table of rooted nombers.									The authors names.
1.	Rootes.	2	3	4	5	6	7	8	9	10	Rootes.
2.	Squares.	4	9	16	25	36	49	64	81	100	Squares.
3.	Cubikes.	8	27	64	125	216	343	512	729	1000	Cubes.
4.	Squares of Squares.	16	81	256	625	1296	2401	4096	6561	10000	Longe Cubes.
5.	Surfolides.	32	243	1024	3125	7776	16807	32768	59049	100000	Squares of cubes
6.	Squares of cubes	64	729	4096	15625	46656	117649	262144	531441	1000000	Cubike Cubes.
7.	Seconde Surfolides.	128	2187	16384	78125	279936	823543	2097152	4782969	10000000	Longe Cubike Cubes.
8.	Squares of squared squares.	256	6561	65536	390625	1679616	5764801	16777216	43046721	100000000	Squares of Cubike Cubes.
9.	Cubes of Cubes.	512	19683	262144	1953125	10077696	40353607	134217728	387420489	1000000000	Cubes of Cubike Cubes.
10	Squares of Surfolides.	1024	59049	1048576	9765625	60466176	282475249	1073741824	3486784401	10000000000	Longe Cubes of Cubike Cubes.

Product Rule

Exploration 1: Look at the example problem and set up problems 1-3 using the color counters. How do you think we get from the problem to the answer?

Example: $x^3 \cdot x^4$  **Answer:** x^7	1. $x \cdot x^3$ **Answer:**	**2.** $a^2 \cdot a^2$ **Answer:**	**3.** $p^2 \cdot p^2$ **Answer:**

What pattern do you notice? _____

Exploration 2: Explore multiplying exponents with the same base by completing the table below. Use the last row to write your own example.

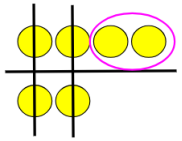
	Column 1 rewritten in expanded form	**Column 2 rewritten in exponential form**
$2^3 \cdot 2^5$	$2 \cdot 2 \cdot 2 \quad 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$	2^8
$4^5 \cdot 4^2$		
$3^1 \cdot 3^6$		
$x^4 \cdot x^7$		
$(-2)^2 \cdot (-2)^3$		
$(-x)^4 \cdot (-x)^3$		
$(\frac{1}{2})^2 \cdot (\frac{1}{2})^4$		

Compare columns 1 and 3, what pattern do you see?

_____

Quotient Rule

Exploration 1: Look at the example problem and set up problems 1-3 using the color counters. How do you think we get from the problem to the answer?

Example: $\frac{x^4}{x^2}$  **Answer:** x^2	1. $\frac{x^3}{x^2}$ **Answer:**	**2.** $\frac{c^6}{c^2}$ **Answer:**	**3.** $\frac{f^7}{f}$ **Answer:**

What pattern do you notice? _____

Exploration 2: Explore dividing exponents with the same base by completing the table below. Use the last row to write your own example.

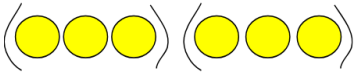
	Column 1 rewritten in expanded form	**Column 2 rewritten in exponential form**
$\frac{2^5}{2^3}$	$\frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2}$	2^2
$\frac{x^9}{x^3}$		
$\frac{2^5}{2^3}$		
$\frac{2x^2y^3}{4xy^2}$		
$\frac{-6x^2y^6}{4xy^2}$		

Compare columns 1 and 3, what pattern do you see?

_____

Power Rule

Exploration 1: Look at the example problem and set up problems 1-3 using the color counters. How do you think we get from the problem to the answer?

Example: $(x^3)^2$	1. $(x^2)^4$	**2.** $(r^3)^3$	**3.** $(h^5)^2$
 **Answer:** x^6	**Answer:**	**Answer:**	**Answer:**

What pattern do you notice? _____

Exploration 2: Explore raising an exponent or product of exponents to a power by completing the table below. Use the last row to write your own example.

	Column 1 rewritten in expanded form	**Column 2 rewritten in exponential form**
$(2^3)^4$	$(2 \cdot 2 \cdot 2)\ (2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)$	2^{12}
$(4^5)^2$		
$(x^4)^9$		
$(xy)^5$		
$(3x^2)^4$		
$(-5x^2y^3)^2$		
$(-x^3yz^2)^4$		

Compare columns 1 and 3, what pattern do you see?

_____

EXPONENT RULES

MULTIPLYING MONOMIALS

To multiply monomials, use the **PRODUCT RULE:** $x^a \cdot x^b =$

Directions: Find each product.

17. $x^2 \cdot x^3$	**18.** $a^9 \cdot a$	**19.** $w^7 \cdot w^4$

- **Examples with Coefficients:**
  - MULTIPLY the coefficients.
  - SIMPLIFY the variables with the product rule.

20. $(4x^2) \cdot (3x^5)$	**21.** $(3x^6)(5x^2)$	**22.** $5x^2 \cdot 6x^4$
23. $(-4a^3b)(3a^2b^5)$	**24.** $-7p^9q^3r \cdot -4p^2q^6r^4$	**25.** $(8x^4y^2)(-3x^4y^9)$
26. $2y \cdot -5y^2 \cdot 3y^3$	**27.** $(ab)(6a^5b)(-ab)$	**28.** $-2xy \cdot xy \cdot 3x^2y^3$
29. $6m \cdot 7m^2n \cdot n^4$	**30.** $(8c^2d)(10c^3d^5)$	**31.** $-4(rs^2)(-5r^4s)$
32. $(-6a^2b) \cdot \left(\frac{1}{2}ab\right)$	**33.** $12y \cdot \left(\frac{2}{3}xy^4\right)$	**34.** $\frac{1}{4}(8mn)(-6m^2n^2)$

DIVIDING MONOMIALS

To divide monomials, use the **QUOTIENT RULE:** $\frac{x^a}{x^b} =$

EXAMPLES

Directions: Find each quotient.

1. $\frac{x^5}{x^3}$	**2.** $\frac{k^{12}}{k^2}$	**3.** $\frac{m^3}{m^3}$
4. $\frac{a^6b^4}{a^2b^3}$	**5.** $\frac{p^7q^{16}}{p^4q^{12}}$	**6.** $\frac{x^{20}y^9z^2}{x^5y^9z}$

- **Examples with Coefficients:**
  - DIVIDE the coefficients.
  - SIMPLIFY the variables with the quotient rule.

7. $\frac{6x^4}{2x^3}$	**8.** $\frac{14r^2s^2}{7rs}$	**9.** $\frac{-36c^2d^5}{4c^2d^3}$
10. $\frac{-15x^6y^5z}{-3x^5y^3}$	**11.** $\frac{4n^5}{8n}$	**12.** $\frac{36m^9n^5}{54m^3n^2}$

Name: _____ **Unit 6:** Exponents & Exponential Functions

Date: _____ **Bell:** _____ **Homework 1:** Adding, Subtracting, & Multiplying Monomials

Directions: Simplify the following monomials.		
1. $-3a + 52a$	**2.** $-12x^2y - 3x^2y$	**3.** $16ab^3 - 43ab^3$
4. $-15m - (-15m)$	**5.** $11c^2d^2 - 20c^2d^2$	**6.** $4ab + 13bc$
7. $-5a^2b^2 - a^2b^2$	**8.** $8x^2 - x^2 - 12x^2 + 2x^2$	**9.** $16x^2y - 4xy^2 - 5x^2y + 10xy^2$
10. Subtract $-2x$ from $-8x$.	**11.** From $13xy^2$, subtract $21xy^2$	**12.** Subtract $17a^2b$ from $2a^2b$.

Directions: Use the product rule to simplify the following monomials.		
13. $b^6 \cdot b^4$	**14.** $(x^3y^5)(x^8y^{10})$	**15.** $3a^4 \cdot 5a^3$
16. $5a(-3b)(-2a^2b^3)$	**17.** $11(4cd)(-cd^5)$	**18.** $(-xy^3)(4x^2y)$
19. $(-15xy^4) \cdot \left(-\frac{1}{3}xy^3\right)$	**20.** $(5a^2bc^3) \cdot \left(\frac{1}{5}abc^4\right)$	**21.** $\frac{1}{3}(2a^3b)(6b^3)$
22. $(7a)(3ab) - 4a^2b$	**23.** $(2y^2)(4xy^3) + (3xy^4)(5y)$	
24. $(2xy)(-4x^2) + (6x)(6x^2y)$	**25.** $(2ab^2)(4a^2b^3) - (10a^3b)(6b^4)$	

Name: _____ **Unit 6:** Exponents & Exponential Functions

Date: _____ **Bell:** _____ **Homework 3:** Dividing Monomials

Directions: Simplify the following monomials. **SHOW ALL STEPS!**

1. $\frac{y^4}{y^2}$	**2.** $\frac{k^6}{k^6}$	**3.** $\frac{x^4y^5}{x^3y^2}$
4. $\frac{mn^3}{n^2}$	**5.** $\frac{15a^3}{3a}$	**6.** $\frac{8x^5y^4}{4x^2y^2}$
7. $\frac{6a^5b^7}{-2a^3b^7}$	**8.** $\frac{-20x^3y^2}{-5x^3y}$	**9.** $\frac{-16ab^4}{4b^3}$
10. $\frac{21m^8n^5}{27m^5n^4}$	**11.** $\frac{-15x^5y^4}{45xy^3}$	**12.** $\frac{7p^2q^2}{14p^2q^2}$
13. $\frac{(-2m^4)^2}{8m^2}$	**14.** $\frac{(2a^3b^4)^3}{(2ab^2)^5}$	**15.** $\frac{(3x^5y^3)^5}{(6x^{10}y^7)^2}$
16. $\left(\frac{4x^7}{6x}\right)^2$	**17.** $\left(\frac{2y^5}{3y^2}\right)^3$	**18.** $\left(\frac{5x^6y^2}{10x^4y}\right)^2$

19. $\frac{(-4a^2b)(-3a^7b)}{6a^7b^2} + 16a^2$

20. $\frac{(2x^3)^2(3y^4)^3}{12x^4y^5} - 4x^2y^7$

Title: Powers and Perimeters **Grade level/content area: 8th Grade Algebra**

Author(s):
Anastashia Pelletier

Date lesson will be taught: March 10th/11th

Source of the lesson:

Teacher modified from school's CLT Plans

CONCEPT STATEMENT

In this lesson, students will apply and extend their knowledge of the laws of exponents, focusing on the Power Rule. They will learn how to simplify expressions that include coefficients and variables raised to powers and apply these skills to geometric contexts such as calculating perimeter and area of rectangles and triangles using algebraic expressions. Mastery of exponent rules, particularly in the context of real-world problems, prepares students for success on the SOL and deepens algebraic reasoning.

Important Vocabulary:

Power Rule – To raise a power to a power, multiply the exponents.
Monomial – A single algebraic term including coefficient, variables, and exponents.
Coefficient – A numerical factor in a term.
Perimeter – The distance around a shape.
Area – The number of square units inside a shape.

LESSON OBJECTIVES

Students will be able to… apply the power rule for exponents to simplify monomial expressions, use laws of exponents to solve problems involving geometric applications, and understand and explain why exponent rules apply in various contexts.

VIRGINIA SOL OBJECTIVE(s) ADDRESSED

A.EO.3 The student will derive and apply the laws of exponents.

MATERIALS NEEDED (Resources, supplies, and handouts)

Pencils, Chromebook, and notebook
'Product Rule and Quotient Rule' half sheet
'Laws of Exponents Task Card' work page and Schoology access
"HW2: Power Rule and Geometry" worksheet

SAFETY CONSIDERATIONS

Students will be instructed to use all materials for their intended use.

ENGAGEMENT	Estimated Time: 10 minutes
Teacher and Student Activity	**Probing Questions**
Students will begin with a warm-up using "Product Rule and Quotient Rule" half sheets to activate prior knowledge.	• What patterns did we see when multiplying or dividing powers with the same base? • How do these rules help simplify expressions faster?

EXPLORATION	Estimated Time: 15 minutes
Teacher and Student Activity	**Probing Questions**
Students will open their "Powers of Monomials" notes and review problems 1–3 with the teacher, which address simplifying variables using the power rule.	
The class will then transition into simplifying expressions that include both coefficients and exponents (problems 4–9).	
Students will practice independently on problems 10 and 12 for 5 minutes, followed by a class discussion. Students will then apply PEMDAS to simplify mixed expressions.	• What happens when we apply the power rule to both variables and coefficients? • How do we know when to multiply vs. add exponents?

EXPLANATION	Estimated Time: 30 minutes
Teacher and Student Activity	**Probing Questions**
Students will transition to exploring geometric applications. The teacher will explain that on the SOL, students will encounter problems involving algebraic expressions for perimeter and area, and formulas will not be provided.	
Teacher will guide students through problems 16–20 in their notes, focusing on the use of formulas for the perimeter and area of rectangles and the simplification of expressions involving monomials.	• How does using exponents simplify area/perimeter calculations? • Why is it important to memorize basic geometry formulas?

ELABORATION	Estimated Time: 15 minutes
Teacher and Student Activity	**Probing Questions**
Students will work on Task Cards 1–20 in Schoology to apply the power rule in multiple contexts, including numerical and geometric applications.	
The teacher will provide one-on-one support to students who need clarification.	• Which task card did you find most challenging, and why? • How could these exponent rules be useful in everyday math situations?

EVALUATION	Estimated Time: 10 minutes
Teacher and Student Activity	**Probing Questions**
Students will reflect on their understanding by answering:	• What is something new we learned about the power rule today? • What happens if the exponent in the denominator is larger than the one in the numerator?
Teacher will check select problems from the task cards for mastery and use them to address misconceptions. Any unfinished work becomes homework.	

PRODUCT RULE WARM – UP (A)

Name: _____
Date: _____ Class: _____

Write in simplest form.

1. $r^2 \cdot 6r^4 \cdot 2r^5$ _____

2. $mn^2p^3\ (m^2n^3p^3)$ _____

3. $5ab^2c^8 \cdot 6a^5bc^4(abc^2)$ _____

PRODUCT RULE WARM – UP (A)

Name: _____
Date: _____ Class: _____

Write in simplest form.

1. $r^2 \cdot 6r^4 \cdot 2r^5$ _____

2. $mn^2p^3\ (m^2n^3p^3)$ _____

3. $5ab^2c^8 \cdot 6a^5bc^4(abc^2)$ _____

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Name: _____
Date: _____ Class: _____

QUOTIENT RULE WARM – UP (A)

Write in simplest form.

1. $\frac{m^{10}n^{12}ps^8}{mn^5s^6}$ _____

2. $\frac{12x^5yz^9}{xy \cdot 4z^6}$ _____

3. $\frac{5de^7}{2e^3} \cdot \frac{4d^2ef^{17}}{def^6}$ _____

Name: _____
Date: _____ Class: _____

QUOTIENT RULE WARM – UP (A)

Write in simplest form.

1. $\frac{m^{10}n^{12}ps^8}{mn^5s^6}$ _____

2. $\frac{12x^5yz^9}{xy \cdot 4z^6}$ _____

3. $\frac{5de^7}{2e^3} \cdot \frac{4d^2ef^{17}}{def^6}$ _____

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Name:	Date:
Topic:	Class:

Main Ideas/Questions	Notes/Examples
Powers of Monomials	To raise a monomial to a power, use the **POWER RULE:** $(x^a)^b =$

Examples

Directions: Simplify.

1. $(x^2)^5$	**2.** $(m^7n^4)^4$	**3.** $(cd^2)^3$

- **Examples with Coefficients:**
  - Raise the coefficient to the given power.
  - SIMPLIFY the variables with the power rule.

4. $(5x^7)^2$	**5.** $(2x^2y)^5$	**6.** $(-2p^4q^6)^2$
7. $(-4c^3d^4)^4$	**8.** $(-3x^2)^3$	**9.** $\left(\frac{1}{2}a^3b^4c^5\right)^3$

Mixed Practice

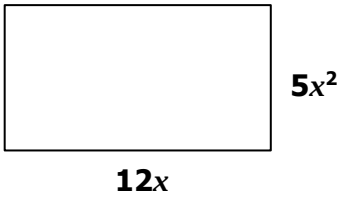
Directions: Simplify each expression completely.

10. $(x^3y^3)^3 \cdot xy^2$	**11.** $a^3 \cdot (-a^2b)^4$
12. $(-2ab^2)^2 \cdot (3a^2b)^2$	**13.** $(6a^2b)^3 \cdot \left(\frac{1}{3}abc\right)^2$
14. $(2a^2)^3 + (a^4)(3a^2)$	**15.** $(3x^3y)^4 - (7x^5y)^2 \cdot x^2y^2$

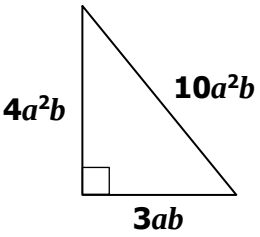
Geometric Applications

Directions: Find the **perimeter** and **area** of each figure below.

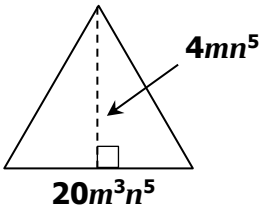
16.



17.

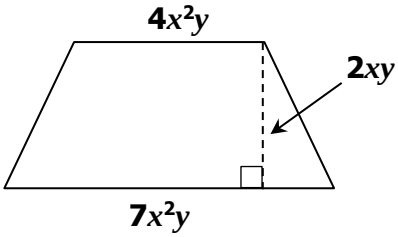


18. (Assume the triangle below is equialteral.)

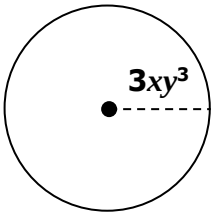


Directions: Find the **area** of each figure below.

19.



20.



1

Simplify.

$8x^3 + 2x^3$

2

Simplify.

$3a^5b^2 - 7a^5b^2$

3

Simplify.

$m^4 \cdot m^5$

4

Simplify.

$c^3d \cdot cd^6$

5

Simplify.

$$-3w^2 \cdot -4w^6$$

6

Simplify.

$$(12a^2b^2) \cdot \left(\frac{3}{4}a^3b^4\right)$$

7

Simplify.

$$7y \cdot (-2y^3) + 9y^4$$

8

Simplify.

$$9p^{12}q^7 - 2p^5q^6 \cdot 4p^7q$$

9

Simplify.

$$(k^4)^5$$

10

Simplify.

$$(2m^5)^3$$

11

Simplify.

$$(-6a^5)^2$$

12

Simplify.

$$(-3x^6y^4)^3$$

13

Simplify.

$$(8r^5s^2)^2 - 13r^{10}s^4$$

14

Simplify.

$$(-m^3n^4)^4 - 8m^{12}n^{16}$$

15

Simplify.

$$\frac{w^7}{w^4}$$

16

Simplify.

$$\frac{36c^8}{4c^4}$$

11

Simplify.

$$\frac{x^{15}y^2z^{10}}{x^8y^2z^2}$$

18

Simplify.

$$\frac{-24p^{20}q^{18}}{8p^4q^{12}}$$

19

Simplify.

$$\frac{8mn^5}{2mn} + 19n^4$$

20

Simplify.

$$2x^8y^{15} - \frac{40x^{10}y^{24}}{5x^2y^9}$$

Name: _____ **Unit 6:** Exponents & Exponential Functions

Date: _____ **Bell:** _____ **Homework 2:** Powers of Monomials & Geometric Applications

**** This is a 2-page document! ****

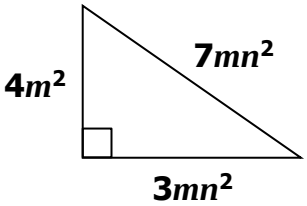
Directions: Simplify the following monomials.

1. $(x^4)^2$	**2.** $(k^5)^9$	**3.** $(m^2n^7)^3$
4. $(2w^3)^6$	**5.** $(3y^3)^4$	**6.** $(-4x^2)^2$
7. $(-5y^3)^3$	**8.** $(-a^9b)^4$	**9.** $\left(\frac{1}{2}x^4\right)^7$
10. $2(3a^2)^3$	**11.** $\frac{1}{2}(4k^5)^2$	**12.** $-6\left(\frac{2}{3}p^8\right)^3$
13. $(m^5n^3)^7 \cdot m^2n$	**14.** $(2xy)^2(-3x^2)(4y^2)$	**15.** $(2x^3y^2z^2)^3(x^2z)^4$
16. $(-xy)^2 \cdot (2x^9y^5)^4$	**17.** $(-4mn)^3 \cdot (-2m^2)^3$	**18.** $-3(2x^4)(4x^5y)^2$
19. $(-18m^2n)^2\left(-\frac{1}{6}mn^2\right)$	**20.** $(-3r^3s^5)^2 - r^6s^{10}$	**21.** $(-2x^5y^7)^3 + 7x^{15}y^{21}$

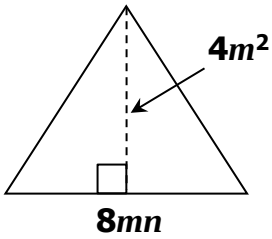
Directions: Find the **perimeter** and **area** of each figure below.

22.

23.

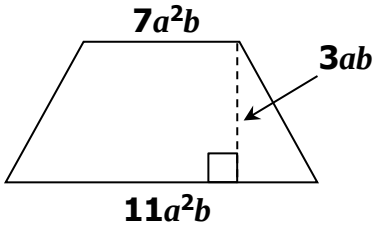


24. (Assume the triangle below is equilateral.)

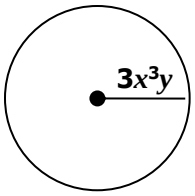


Directions: Find the **area** of each figure below.

25.



26.



Title: Getting in the Negative **Grade level/content area: 8th Grade Algebra**

Author(s):
Anastashia Pelletier

Date lesson will be taught: March 12th/13th

Source of the lesson:

Teacher modified from school's CLT Plans

CONCEPT STATEMENT

In this lesson, students will extend their knowledge of the laws of exponents by focusing on the Negative Exponent Rule. Building from their prior understanding of the product, quotient, and power rules, students will explore how to simplify monomial expressions with negative exponents. They will learn how to interpret negative exponents as reciprocals and integrate all exponent rules when simplifying complex expressions. The lesson connects procedural fluency with conceptual understanding, laying the groundwork for further algebraic manipulation and standardized test readiness.

Important Vocabulary:

Negative Exponent Rule – A base with a negative exponent represents the reciprocal of the base with a positive exponent.
Reciprocal – The flipped version of a fraction; used in rewriting negative exponents.

LESSON OBJECTIVES

Students will be able to… apply the negative exponent rule to simplify monomial expressions, integrate the use of product, quotient, and power rules in simplifying expressions with negative exponents, and demonstrate understanding through guided, independent, and technology-based activities.

VIRGINIA SOL OBJECTIVE(s) ADDRESSED

A.EO.3 The student will derive and apply the laws of exponents.

MATERIALS NEEDED (Resources, supplies, and handouts)

Pencils, Chromebook, and notebook
'Power of a Product and Power of a Power' half-sheet
Mixed Practice Note Bundle: Product, Quotient, and Power Rules
'Negative Exponent' Desmos activity
'Simplify Expressions with Negative Exponents' Edia activity

SAFETY CONSIDERATIONS

Students will be instructed to use all materials for their intended use.

ENGAGEMENT	Estimated Time: 10 minutes
Teacher and Student Activity	**Probing Questions**
Students will complete a warm-up using the "Power of a Product and Power of a Power" half-sheet to refresh their understanding of the power rule.	• What happens when the exponent in the denominator is higher than in the numerator? • What happens when you subtract a smaller number from a larger one?

EXPLORATION	Estimated Time: 15 minutes
Teacher and Student Activity	**Probing Questions**
Students will complete a graphic organizer to summarize product, quotient, and power exponent rules.	
Using scrap paper, student will create an expression that uses 2-3 variables with a combination of the 3 exponent rule that they have learned. Then student will pass the scrap paper to another student in their pod. That student will then work on simplifying the expression to the lowest form.	
If there is 3-4 people in the pod, then the scrap is checked by the remaining 1-2 students in the pod.	

EXPLANATION	Estimated Time: 30 minutes
Teacher and Student Activity	**Probing Questions**
Students will review and check their previous homework on the board. Then, turning to the Negative Exponent Rule page in their notes, students will follow along as the teacher introduces how negative exponents require flipping the base across the fraction bar.	
Teacher will model how to rewrite negative exponents using problems 1 and 3. Students will try rewriting negative exponents independently in problem 2	• When you're rewriting the negative exponent, what do you notice about how the expression changes?
Next, students will see how to combine negative exponents with the product rule in problems 4–6. Teacher emphasizes simplification first, then flipping if needed. Teacher will prompt a discussion about problems 6 and 8.	• How is problem 6 (product rule) different from problem 8 (power rule)? • How does simplifying before flipping the base help when combining negative exponents with other exponent rules?
The teacher will model problems 12, 13, 14, 15, and 17, highlighting how variables can be 'sorted and put away' after simplification. Students will observe the process and	• How does this help in organizing and understanding the final expression?

understand how to organize variables during simplification.	
To reinforce order of operations, teacher will guide problems 20 and 24. Students will independently solve 21, 23, and 25, with a challenge problem incentive for early finishers.	• How do you apply the order of operations when working with negative exponents? • How do you decide the order in which to apply the exponent rules?

ELABORATION	**Estimated Time: 15 minutes**
Teacher and Student Activity	**Probing Questions**
Students will complete the "Negative Exponent" Desmos activity on their Chromebooks to apply the rule in interactive contexts.	
Afterwards, students will begin the Edia practice titled "Simplify Expressions with Negative Exponents," which includes 10 problems.	
Teacher will circulate to offer individualized support and monitor for misconceptions.	

EVALUATION	**Estimated Time: 10 minutes**
Teacher and Student Activity	**Probing Questions**
Formative assessment will occur as the teacher circulates and observes student work on notebook problems and technology tasks. Misconceptions will be addressed in real-time or during group check-ins.	• How does the rule for negative exponents compare to positive exponents? • When is it best to simplify first, and when should we flip the expression first?

POWER OF A PRODUCT RULE WARM – UP (A)

Date: _____ Class: _____

Write in simplest form.

1. $(s^3t^5)^2(st^2)^3$ _____

2. $((d^5e^4)^3)^5$ _____

3. $\frac{(lmn^3)^{10}}{(l^4)^2(m^2n^4)^3}$ _____

POWER OF A PRODUCT RULE WARM – UP (A)

Date: _____ Class: _____

Write in simplest form.

1. $(s^3t^5)^2(st^2)^3$ _____

2. $((d^5e^4)^3)^5$ _____

3. $\frac{(lmn^3)^{10}}{(l^4)^2(m^2n^4)^3}$ _____

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POWER OF A POWER RULE WARM – UP (A)

Name: _____
Date: _____ Class: _____

Write in simplest form.

1. $(c^4)^5 \cdot (c^2)^3$ _____

2. $\frac{a(b^4)^5}{(b^3)^3}$ _____

3. $(3x^7)^2[(y^6)^3]\,[(x^2)^2]$ _____

POWER OF A POWER RULE WARM – UP (A)

Name: _____
Date: _____ Class: _____

Write in simplest form.

1. $(c^4)^5 \cdot (c^2)^3$ _____

2. $\frac{a(b^4)^5}{(b^3)^3}$ _____

3. $(3x^7)^2[(y^6)^3]\,[(x^2)^2]$ _____

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EXPONENT RULES

Graphic Organizer

Name	Rule	Examples
ADDING & SUBTRACTING MONOMIALS	**COMBINE LIKE TERMS!!!** (DO NOT CHANGE common variables and exponents!)	**1.** $9x^2y - 10x^2y =$ **2.** Subtract $6w$ from $8w$.
PRODUCT RULE	$x^a \cdot x^b =$	**1.** $h^2 \cdot h^6 =$ **2.** $(-2a^2b) \cdot (7a^3b) =$
POWER RULE	$(x^a)^b =$	**1.** $(x^2)^3 =$ **2.** $(-2m^5)^2 \cdot m^3 =$
QUOTIENT RULE	$\frac{x^a}{x^b} =$	**1.** $\frac{27x^5}{42x} =$ **2.** $\frac{(y^2)^2}{y^4} =$
NEGATIVE EXPONENT RULE	$x^{-a} =$	**1.** $-5x^{-2} =$ **2.** $\frac{4k^2}{8k^5} =$
ZERO EXPONENT RULE	$x^0 =$	**1.** $7x^0 =$ **2.** $\frac{(w^4)^2}{w^8} =$

Name:	Date:
Topic:	Class:

Main Ideas/Questions	Notes/Examples
Negative Exponents	Negative exponents can be rewritten using positive exponents using the **NEGATIVE EXPONENT RULE:** $x^{-a} =$
Examples	**Directions:** Rewrite each expression using positive exponents.

1. x^{-5}	**2.** $3m^{-2}$	**3.** $-7a^{-4}b^{3}$

Directions: Simplify each expression. Make sure final answers contain only positive exponents. (**Hint**- use the rules, then move variables at the end!)

4. $w^{7} \cdot w^{-9}$	**5.** $4c^{8}d^{-3} \cdot 5c^{-5}d^{-1}$
6. $6x^{-8} \cdot -3x^{-3}$	**7.** $(a^{-5}b^{8}c^{-12})(a^{7}b^{-3}c^{7})$
8. $(8p^{5})^{-2}$	**9.** $(5y^{2})^{-3}$
10. $(3rs^{-3})^{-4}$	**11.** $(6x^{5}y^{-4})^{-2}$
12. $\frac{h^{2}}{h^{5}}$	**13.** $\frac{c^{-2}d^{-1}}{c^{7}d^{-2}}$
14. $\frac{14w^{4}}{7w^{-2}}$	**15.** $\frac{-10m^{2}n}{2m^{3}n^{-5}}$

	16. $\frac{36x^{-4}y^{8}}{12y^{7}}$	**17.** $\frac{15a^{2}b^{5}c^{8}}{18a^{2}b^{3}c^{9}}$
	18. $\frac{-4pq^{5}r^{3}}{8p^{2}q^{2}r^{10}}$	**19.** $\frac{-9r^{2}s^{6}t^{4}}{54r^{5}s^{2}t^{8}}$
Mixed Practice	**20.** $(4x^{3}y^{6})^{-2} + (2x^{2}y^{4})^{-3}$	**21.** $(x^{2}y^{3})^{-2} \cdot (x^{5}y^{4})^{-3}$
	22. $\frac{(6a^{3})(5a^{9})}{-12a^{14}}$	**23.** $\frac{(3xy)^{2}(2x^{4}y^{3})}{6x^{8}y}$
	24. $\frac{(-6x^{4}y^{6})^{2}}{(-4x^{-3}y^{5})^{3}}$	**25.** $\frac{(6bc^{3})(3b^{5}c^{2})}{(5b^{5}c^{2})(2b^{3}c^{6})}$
Challenge Problem! 	**Simplify completely:** $\left(\frac{\left(2x^{4}y^{-3}\right)^{-2} \cdot \left(2x^{-1}y^{-2}\right)^{4}}{2x^{-7}y^{-3}}\right)^{3}$	

PRACTICE: EXPONENT RULES (POSITIVE POWERS ONLY)

Name: _____
Date: _____ Class: _____

Write each expression in simplest form.

1. $(\frac{m^4n^2}{mn^2})^3$ _____

2. $a^3b^5c^2(a^9(\frac{bc^6}{c^3}))^2$ _____

3. $\frac{q^4r^2s}{r} \cdot \frac{(qr^2)^3}{r^3} \cdot \frac{s^5}{qs^2}$ _____

4. $(\frac{x^5}{x})^4x^8$ _____

5. $ef^4g^7[(fg^5)^0]$ _____

6. $\frac{16j^9(3jk^6)^3}{6j^3k^2}$ _____

7. $4t^5v^2 \cdot \frac{3w^8[(tv^3)^2]^4}{6tv^2w^7}$ _____

8. $(pq^5r^{10})(p^8q^2r^0)$ _____

9. $[h^3(h^2)^6]^2 + h^8$ _____

10. $\frac{kp^5(k^3)^2}{3p^4}$ _____

11. $fg^4[\frac{(g^3)^2}{g^0}]^2$ _____

12. $d^6e^4f^3 \cdot (de)^5 \cdot [e^0(ef^4)^3]$ _____

13. $\frac{42m^{12}n^8}{2m^5n^2}$ _____

14. $\frac{4x^9y^{10}}{xy^6} \cdot \frac{3x^2}{x^3y^4} \cdot \frac{(xy^2)^8}{y^3}$ _____

15. $(\frac{b}{c})^5(\frac{b^3}{c^2})^4$ _____

16. $h^4j^3 \cdot (j^2)^5 \cdot j^0k^2 \cdot (jk^4)^2$ _____

17. $\frac{4xy^9z^6}{2yz^2}$ _____

18. $a^4b^6[\frac{a^7}{a}]$ _____

19. $\frac{[3(x^2y^4)^0]^2}{(x^2)^4}$ _____

20. $\frac{[(\frac{f^3}{g})^4]^2}{(fg^2)^3}$ _____

PRACTICE: PRODUCT RULE, QUOTIENT RULE, AND ZERO POWER RULE

Name: _____
Date: _____ Class: _____

Write each expression in simplest form.

1. $\frac{7b^3c^2}{c^2} \cdot \frac{4bc^2c^6}{14b^0c(c^3)}$ _____

2. $6x^6y^4[3x^5y(xy^2)^0]$ _____

3. $\frac{m^8n^{12}p^{16}}{2mn^3p^6(\frac{m^4}{m})}$ _____

4. $abc^0 \cdot 6ab$ _____

5. $\frac{\frac{k^7}{k^3}}{jk^2k^2}$ _____

6. $\frac{e^4gh^9h^6}{fgh^3}$ _____

7. $\frac{t^5}{w^6} \cdot \frac{v^{12}w^{15}}{vw^3} \cdot \frac{t^7}{tv^3}$ _____

8. $r^2s^7q^8(rs^2)$ _____

9. $\frac{16x^5y^{10}}{5xy^2} \cdot \frac{5x^2}{2x^3y}$ _____

10. $k^5mn^0p^5(\frac{5km^6np^4}{m^2})$ _____

11. $\frac{a^2b^3c}{3ab^2}$ _____

12. $d^4ef^5g^8(ef^2g^0h^6)$ _____

13. $\frac{m^{12}n^2}{mn^8} \cdot \frac{mn^5p^7}{n^3p^2}$ _____

14. $j^6k^4(\frac{6j^5k^9(j^8k)}{2jk^2})$ _____

15. $\frac{x^5yz^{18}}{xz^3}(\frac{y^9z^4}{y^3z^2})^0$ _____

16. $\frac{35n^6}{n^2(5n^2)}$ _____

17. $fg^2h^0(g^3h^6)(f^5gh)$ _____

18. $\frac{(\frac{12sr^6}{r^3})}{4sr^2}$ _____

19. $\frac{5u^8v^3w}{u^2v^2w}(u^6vw)$ _____

20. $r^8st^3q^5[(3qr^6s^{12}t^9)7rs^4]$ _____

BASIC PRACTICE: NEGATIVE EXPONENTS.

Name: _____
Date: _____ Class: _____

Rewrite each expression in simplest form using only positive exponents.

1. $\frac{x^{-3}}{y^{-5}}$ _____

2. $\frac{n^{-3}}{m^{7}}$ _____

3. $\frac{a^{2}b^{-3}}{a^{7}b^{6}}$ _____

4. $\frac{(de^{-2})^{2}}{d^{-1}e^{3}}$ _____

5. $\frac{c^{-8}}{3c^{2}f^{6}} \cdot \frac{f^{-2}}{c^{-1}}$ _____

6. $\frac{r^{2}s^{-3}t^{0}}{r^{-1}s^{-5}t^{3}}$ _____

7. $9v^{-6} \cdot v^{2}$ _____

8. $p^{-4}q^{-8}p^{-3}q^{2}$ _____

9. $\frac{j^{2}k^{-5}}{j^{-2}}$ _____

10. $h^{-3}a^{6}h^{3}$ _____

11. $a^{9}b^{-4}(a^{3})^{-1}$ _____

12. $x^{2}y^{-5}x^{4}y^{3}$ _____

Rewrite each expression using negative exponents.

1. $\frac{a^{-3}b^2}{ab^9}$ _____

2. $\frac{h^6}{h^{10}j^3}$ _____

3. $\frac{c^2}{(c^3)^3}$ _____

4. $\frac{x^5}{x^{17}y^8} \cdot \frac{xy^4}{y}$ _____

5. $\frac{3m^6}{mn^7}\left(\frac{(mn^0)^2}{6m^8n}\right)$ _____

6. $\frac{x^2y^{-2}z^3}{x^8y^4z^6}$ _____

Rewrite each expression in simplest form.

1. $d^6e^{-1}d^{-3}e^5$ _____

2. $\frac{g^{-4}h^3}{(g^2h^4)^{-1}}$ _____

3. $\frac{x^5y^4}{(5x^{-6})^2y^7}$ _____

4. $b^{-2}c^3 \cdot \frac{bc^2}{c^4}$ _____

5. $\frac{yz^8}{z^2} \cdot \frac{z^5}{y^3z^0}$ _____

6. $\frac{5^{-1}r^2st^{10}}{r^5s^{-7}t^4}$ _____

Analysis of Post Test

Post Test Analysis Introduction

After completing the unit, I administered a post test to measure student growth and assess the effectiveness of my instructional strategies. This post assessment was intentionally aligned with the pre-test to allow for a clear comparison of student progress across key learning targets. My goal was not only to evaluate how much students had learned, but also to determine whether the supports and interventions I put in place were effective for all learners, including specific subgroups like male and female students.

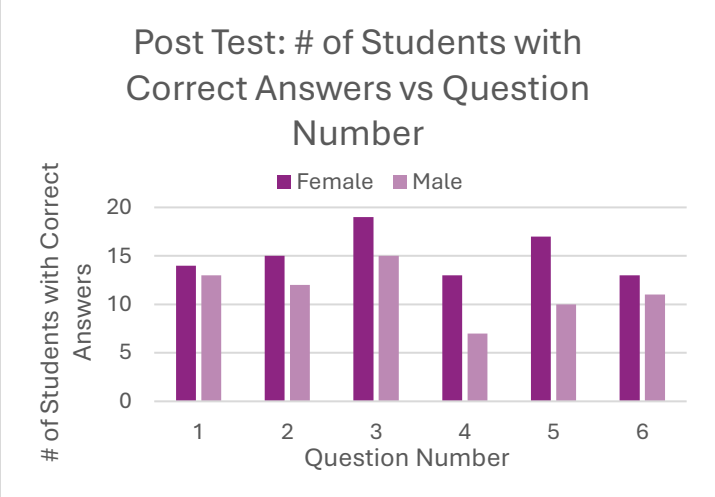
In analyzing the post-test data, I focused on several areas: the number of students who answered each question correctly, how many questions students got right overall, and the average score per question by gender. This breakdown gave me a comprehensive view of both class-wide achievement and individual growth. It also helped me reflect on how my teaching influenced outcomes and how I can continue to adapt my instruction to meet students where they are.

Through this analysis, I was able to celebrate areas of growth, identify where instruction made the most impact, and consider how to provide ongoing support in areas where some students may still be struggling. This process is critical to ensuring that my teaching remains responsive, data-driven, and focused on equity for all students.

Analysis 1: Question-by-Question Performance by Gender

	Total	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6
Female	91	14	15	19	13	17	13
Male	68	13	12	15	7	10	11

Analysis 1 of the post-test data shows how many students answered each question correctly, broken down by gender. Compared to the pre-test, there was a clear improvement across nearly all questions for both male and female students. Notably, Question 4, which had no correct responses on the pre-test, now shows correct answers, especially among female students. This suggests that instructional efforts targeting this area were successful. Female students continue to outperform male students slightly across most questions, with the largest gender gap visible on Question 6, where females had notably higher success. These results suggest not only overall growth but also confirm that specific reteaching and review strategies were effective.

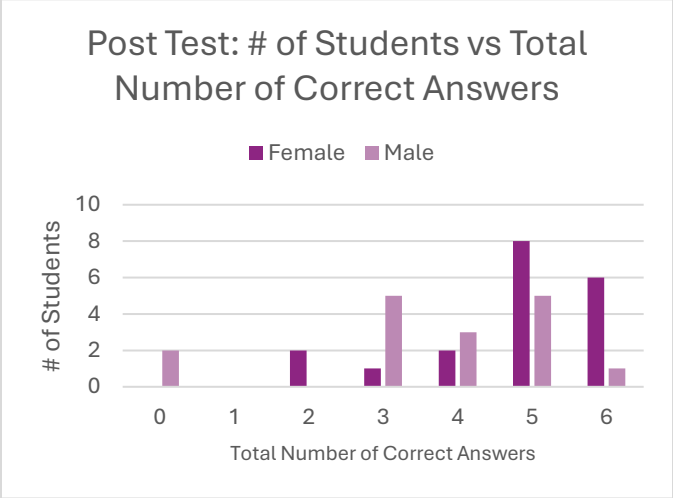


	Female	*Male*
Median	14.50	11.50
Mode	13.00	N/A
Range	6.00	3.00
Minimum	13.00	8.00
Maximum	19.00	7.00
Mean	15.17	15.00
Standard Deviation	2.40	2.73
Variance	5.77	7.47

Analysis 2: Distribution of the Number of Fully Correct Questions by Gender

	0	1	2	3	4	5	6
Female	0	0	2	1	2	8	6
Male	2	0	0	5	3	5	1

This analysis reflects the total number of questions each student got correct on the post-test. The score distribution shifted dramatically, with more students achieving higher scores. Many students scored 4, 5, or even 6 correct answers, showing significant gains in mastery. The number of students with very low scores (0–2) decreased substantially, demonstrating improved understanding across the class. This upward trend confirms that instruction was generally effective and that most students were able to meet the learning targets by the end of the unit. Female students continue to have a slight edge in performance, but both groups showed strong gains, minimizing earlier performance gaps.

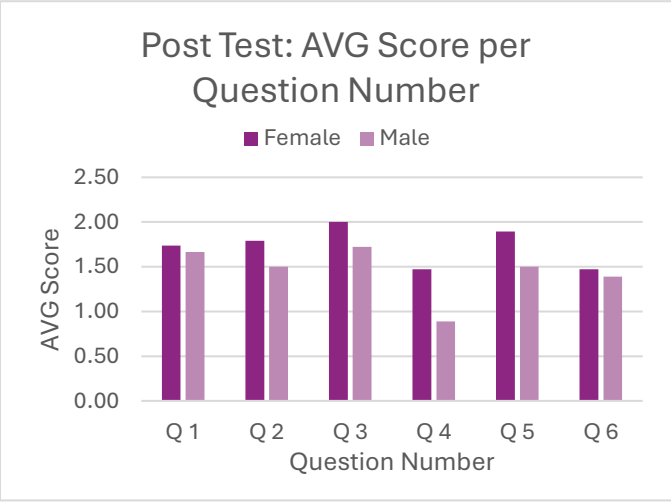


Analysis 3: Average Scores by Question and Grade Percentage by Gender

	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6
Female	1.74	1.79	2.00	1.47	1.89	1.47
Male	1.67	1.50	1.72	0.89	1.50	1.39

	Pre: AVG Grade %
Female	86%
Male	72%

Analysis 3 offers a closer look at average performance per question and overall grade percentage by gender. The average scores for both males and females improved across every question. For instance, female averages now range from approximately 0.5 to over 0.8 on many questions, while male averages also show steady growth, though they still lag slightly behind. Question 4, which previously had an average of zero, now shows notable gains, affirming the success of focused reteaching. The increase in grade percentages across the board highlights improved content retention and conceptual understanding. These average scores reflect both the strength of instruction and students' ability to close previous knowledge gaps.



	Female	*Male*
Median	1.76	1.50
Mode	1.47	1.50
Range	0.53	0.83
Minimum	1.47	0.89
Maximum	2.00	1.72
Mean	1.73	1.44
Standard Deviation	0.22	0.30
Variance	0.05	0.09

Post Test Analysis Conclusion

The post test data illustrates meaningful student growth and provides valuable feedback on instructional impact. The improvement in Question 4 confirms the benefit of responsive teaching based on assessment data. The narrowing of gender performance gaps suggests that interventions for struggling students were effective, but the slight advantage held by female students indicates an ongoing need to ensure that male students receive sufficient scaffolding and engagement. Moving forward, this data should be used to identify any lingering misconceptions, particularly for students who scored in the middle range (e.g., 3–4 correct answers), and to celebrate progress through self-reflection and goal setting. The post-test serves as both a confirmation of growth and a roadmap for continued support and enrichment.

Professional Learning and Reflection

During my student teaching experience, I had the opportunity to plan, teach, and assess a full unit, beginning with a pre-test and concluding with a post test. Reviewing the post test results showed clear growth across the class and affirmed the effectiveness of my instructional decisions. Many students increased the number of questions they answered correctly, especially on concepts that had been challenging on the pre-test. This growth reflected not only academic progress but also the positive learning environment we built together throughout the unit.

One of the most meaningful parts of my experience was the rapport I developed with students early in my placement. I made it a priority to learn students' names quickly and get to know their personalities, interests, and learning styles. This helped me connect with them on a personal level and build trust. As the weeks progressed, I became more confident in how I communicated, both when giving feedback and offering encouragement. I noticed that when students felt supported and respected, they were more engaged, more willing to take risks, and more open to asking questions.

At the same time, I faced challenges, particularly with pacing and classroom management. Early on, I often ran short on time or rushed through activities. To improve, I started wearing a watch and setting specific time limits for each part of the lesson. This helped me stay on schedule and allowed students enough time to engage meaningfully with the content. I also learned various strategies for maintaining classroom control, such as using proximity, giving clear expectations, and following through consistently. These tools helped me create a structured environment where students could focus and feel successful.

Instructionally, I saw how powerful it is to align learning goals, lesson activities, and assessments. When students performed better on the post test, especially on questions that had previously been difficult, it showed me that reteaching and scaffolding made a difference. The post test data confirmed

that the learning objectives were appropriate, and the strategies I used, like modeling, guided practice, and checking for understanding, effectively supported student success.

This experience helped me grow not only in my instructional skills but also in my ability to connect with students, manage a classroom, and reflect critically on my teaching. As I move forward, I will continue to build strong relationships, use data to guide instruction, and refine my pacing and classroom presence. Student teaching gave me a deeper understanding of how intentional, caring, and responsive teaching can create real opportunities for student growth.