Algebra Station Activities

for NCTM Standards

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Introduction

This book includes a collection of station-based activities to provide students with opportunities to practice and apply the mathematical skills and concepts they are learning. It contains several sets of activities for each of the eight topics: Number and Operations; Equations; Inequalities; Systems; Radical Expressions and Equations; Quadratic Equations and Functions; Polynomials; and Data Analysis. You may use these activities as a complement to your regular lessons or in place of your regular lessons, if formative assessment suggests students have the basic concepts but need practice. The debriefing discussions after each set of activities provide an important opportunity to help students reflect on their experiences and synthesize their thinking. It also provides an additional opportunity for ongoing, informal assessment to inform instructional planning.

Implementation Guide

The following guidelines will help you prepare for and use the activity sets in this book.

Setting Up the Stations

Each activity set consists of four or more stations. Set up each station at a desk, or at several desks pushed together, with enough chairs for a small group of students. Place a card with the number of the station on the desk. Each station should also contain the materials specified in the teacher's notes, and a stack of student activity sheets (one copy per student). Place the required materials (as listed) at each station.

When a group of students arrives at a station, each student should take one of the activity sheets to record the group's work. Although students should work together to develop one set of answers for the entire group, each student should record the answers on his or her own activity sheet. This helps keep students engaged in the activity and gives each student a record of the activity for future reference.

Forming Groups of Students

All activity sets consist of four stations. You might divide the class into four groups by having students count off from 1 to 4. If you have a large class and want to have students working in small groups, you might set up two identical sets of stations, labeled A and B. In this way, the class can be divided into eight groups, with each group of students rotating through the "A" stations or "B" stations.

Assigning Roles to Students

Students often work most productively in groups when each student has an assigned role. You may want to assign roles to students when they are assigned to groups and change the roles occasionally. Some possible roles are as follows:

- Reader—reads the steps of the activity aloud
- Facilitator—makes sure that each student in the group has a chance to speak and pose questions; also makes sure that each student agrees on each answer before it is written down
- Materials Manager—handles the materials at the station and makes sure the materials are put back in place at the end of the activity
- Timekeeper—tracks the group's progress to ensure that the activity is completed in the allotted time
- Spokesperson—speaks for the group during the debriefing session after the activities

Timing the Activities

The activities in this book are designed to take approximately 15 minutes per station. Therefore, you might plan on having groups change stations every 15 minutes, with a two-minute interval for moving from one station to the next. It is helpful to give students a "5-minute warning" before it is time to change stations.

Since the activity sets consist of four stations, the above timeframe means that it will take about an hour and 10 minutes for groups to work through all stations. If this is followed by a 20-minute class discussion as described on the next page, an entire activity set can be completed in about 90 minutes.

Guidelines for Students

Before starting the first activity set, you may want to review the following "ground rules" with students. You might also post the rules in the classroom.

- All students in a group should agree on each answer before it is written down. If there is a disagreement within the group, discuss it with one another.
- You can ask your teacher a question only if everyone in the group has the same question.
- If you finish early, work together to write problems of your own that are similar to the ones on the student activity sheet.
- Leave the station exactly as you found it. All materials should be in the same place and in the same condition as when you arrived.

Debriefing the Activities

After each group has rotated through every station, bring students together for a brief class discussion. At this time you might have the groups' spokespersons pose any questions they had about the activities. Before responding, ask if students in other groups encountered the same difficulty or if they have a response to the question. The class discussion is also a good time to reinforce the essential ideas of the activities. The questions that are provided in the teacher's notes for each activity set can serve as a guide to initiating this type of discussion.

You may want to collect the student activity sheets before beginning the class discussion. However, it can be beneficial to collect the sheets afterward so that students can refer to them during the discussion. This also gives students a chance to revisit and refine their work based on the debriefing session.

Materials List

Class Sets

- calculators
- rulers

Station Sets

- at least 40 red, 25 blue, 25 green, and 20 yellow algebra tiles
- measuring stick
- graphing calculators
- at least 24 green, 16 yellow, 1 red, and 1 blue marbles
- bag to hold marbles
- spaghetti noodles
- slips of paper with $<$, $>$, $\leq$, and $\geq$ written on them
- deck of playing cards that contains only the numbers 2–10
- 3 pieces of red yarn, 3 pieces of blue yarn
- a fair coin

Ongoing Use

- highlighters (yellow specifically)
- index cards (need to be prepared according to specifications in teacher notes for many of the station activities)
- number cubes
- graph paper
- pencils
- tape

Number and Operations

Set 1: Operations with Numbers

Instruction

Goal: To provide opportunities for students to develop concepts and skills related to operations with exponents, powers, scientific notation, expressions, equations, inequalities, and order of operations

NCTM Standards

Understand numbers, ways of representing numbers, relationships among numbers and number systems.

- Develop a deeper understanding of very large and very small numbers and of various representations of them.
- Compare and contrast the properties of numbers and number systems, including the rational and real numbers, and understand complex numbers as solutions to quadratic equations that do not have real solutions.

Understand meaning of operations and how they relate to one another.

- Judge the effects of such operations as multiplication, division, and computing powers and roots on the magnitudes of quantities.

Compute fluently and make reasonable estimates.

- Develop fluency in operations with real numbers, vectors, and matrices, using mental computation or paper-and-pencil calculations for simple cases and technology for more-complicated cases.

Student Activities Overview and Answer Key

Station 1

Students are given a set of eight index cards that contain real number expressions written in exponential and expanded form. Students work together to match cards that show the expressions written in exponential and expanded form. When all the cards have been matched, students work together to simplify the expressions and determine the rules of exponents.

Answers

1. $5^2 \bullet 5$ and $5 \bullet 5 \bullet 5$; $\frac{4^2}{4^2}$ and $\frac{4 \bullet 4}{4 \bullet 4}$; $\left(2^3\right)^2$ and $2^3 \bullet 2^3$; $\frac{3^5}{3^2}$ and $\frac{3 \bullet 3 \bullet 3 \bullet 3 \bullet 3}{3 \bullet 3}$

2. $5^2 \bullet 5 = 5 \bullet 5 \bullet 5 = 5^3$. When you multiply powers with the same base, you add the exponents. $\frac{4^2}{4^2} = \frac{4 \bullet 4}{4 \bullet 4} = 4^0 = 1$. Any number raised to the zero power is equal to 1. $\left(2^3\right)^2 = 2^3 \bullet 2^3 = 2^6$. When you find the power of a power, you multiply the exponents. $\frac{3^5}{3^2} = \frac{3 \bullet 3 \bullet 3 \bullet 3 \bullet 3}{3 \bullet 3} = 3^3$. When you divide powers with the same base, you subtract the exponents.

Station 2

Students are given 12 index cards with real numbers in equivalent forms including integer exponents, radicals, percents, scientific notation, absolute value, rational numbers, and irrational numbers. Students work together to find groups of cards that represent equal numbers. Students write equality statements based on the groups of matching cards.

Answers

1. $\sqrt{7} = 7^{\frac{1}{2}}$; $\frac{32}{4} = 2^3 = \sqrt{64}$; $|-5| = \sqrt{25} = 5^1$; $1.44 \times 10^2 = 12^2$; $80\% = \frac{4}{5}$

2. Answers will vary. Possible answers: $\sqrt{7} = 7^{\frac{1}{2}} = \frac{\sqrt{7}}{1}$; $\frac{32}{4} = 2^3 = \sqrt{64} = 8$; $|-5| = \sqrt{25} = 5^1 = \frac{35}{7}$; $1.44 \times 10^2 = 12^2 = |144|$; $80\% = \frac{4}{5} = 0.80$

Station 3

Students will be given the acronym PEMDAS to help them remember the order of operations. They will use the order of operations: parentheses, exponents, multiplication and division, addition and subtraction to simplify expressions.

Answers

1. $10 \bullet 3 = 30$, multiplication; $2 + 30 = 32$, addition; 32
2. $|-10| = 10$, absolute value; $14 \bullet 2 = 28$, multiplication; $10 - 28 = -18$, subtraction; -18
3. $(30 - 10) = 20$, parentheses; $20 \div 5 = 4$, division; 4
4. $(10 \bullet 2) = 20$, parentheses; $5^2 = 25$, exponents; $3 + 25 = 28$, addition; $28 - 20 = 8$, subtraction; 8

Instruction

Station 4

Students will be given 12 index cards with expressions and integer values on them. Students will work together to simplify six expressions using the appropriate variable. Then students work together to find how changing the integer value of the variables to a negative number affects their answer.

Answers

1. $2x + 10 = 16$; $\frac{3}{4}y = 6$; $b^2 + 10 = 35$; $\frac{(z-3)^2}{5} = \frac{49}{5}$; $\frac{7t^3}{2t^4} = \frac{7}{4}$; $5d^2 + 2d - 1 = 23$
2. $2x + 10 = 4$; $\frac{3}{4}y = -6$; $b^2 + 10 = 35$; $\frac{(z-3)^2}{5} = \frac{169}{5}$; $\frac{7t^3}{2t^4} = \frac{-7}{4}$; $5d^2 + 2d - 1 = 15$
3. $b^2 + 10 = 35$ has the same answer when $b = 5$ and $b = -5$ because when you square both positive and negative numbers, the answer is positive.

Materials List/Setup

Station 1 calculators; eight index cards with the following real number expressions in exponential and expanded form written on them: $5^2 \bullet 5$, $\frac{3 \bullet 3 \bullet 3 \bullet 3 \bullet 3}{3 \bullet 3}$, $\frac{4^2}{4^2}$, $\left(2^3\right)^2$, $\frac{3^5}{3^2}$, $5 \bullet 5 \bullet 5$, $2^3 \bullet 2^3$, $\frac{4 \bullet 4}{4 \bullet 4}$

Station 2 calculators; 12 index cards with the following numbers written on them: $\frac{32}{4}$, $|-5|$, 1.44×10^2, 2^3, $\sqrt{25}$, $\sqrt{7}$, 12^2, $\frac{4}{5}$, $\sqrt{64}$, 80%, 5^1, $7^{\frac{1}{2}}$

Station 3 calculators

Station 4 calculators; 12 index cards with following expressions and integer values of variables written on them: $2x + 10$, $\frac{3}{4}y$, $b^2 + 10$, $\frac{(z-3)^2}{5}$, $\frac{7t^3}{2t^4}$, $5d^2 + 2d - 1$, $z = 10$, $b = 5$, $x = 3$, $t = 2$, $y = 8$, $d = 2$

Instruction

Discussion Guide

To support students in reflecting on the activities and to gather formative information about student learning, use the following prompts to facilitate a class discussion to "debrief" the station activities.

Prompts/Questions

1. What are the rules of exponents for multiplication, division, powers, and a variable raised to the zero power?
2. What are different representations of writing the same number?
3. What is the order of operations? When using the order of operations, do you work from right to left or left to right?
4. What do you do when substituting a variable into an expression?
5. Why is following the order of operations important?

Think, Pair, Share

Have students jot down their own responses to questions, then discuss with a partner (who was not in their station group), and then discuss as a whole class.

Suggested Appropriate Responses

1. When you multiply powers with the same base, you add the exponents. When you divide powers with the same base, you subtract the exponents. When you find the power of a power, you multiply the exponents. Any number raised to the zero power is equal to 1.
2. exponents, square roots, scientific notation, fractions, and decimals
3. Parentheses, Exponents, Multiplication and Division, Addition and Subtraction; Work from left to right.
4. Substitute the value of the variable into the expression and simplify by using the order of operations.
5. The order of operations is a standard used in algebra. Without this standard, an expression or equation could be solved differently, which would result in different answers.

Possible Misunderstandings/Mistakes

- When dividing exponential expressions, incorrectly subtracting the exponent in the numerator from the exponent in the denominator
- Incorrectly working from right to left when using the order of operations
- Neglecting the sign of the variable and the rules of multiplying and dividing positive and negative numbers

Number and Operations

Set 1: Operations with Numbers

Station 1

You will be given eight index cards with the following real number expressions in exponential and expanded form written on them:

$5^2 \bullet 5$	$\frac{3 \bullet 3 \bullet 3 \bullet 3 \bullet 3}{3 \bullet 3}$	$\frac{4^2}{4^2}$	$\left(2^3\right)^2$
$\frac{3^5}{3^2}$	$5 \bullet 5 \bullet 5$	$2^3 \bullet 2^3$	$\frac{4 \bullet 4}{4 \bullet 4}$

Work with other students to match the real number expressions with the same expression written in expanded form. After you have matched the cards into pairs, work together to simplify the expression and figure out the rules of exponents for each expression.

1. Write the four pairs below and simplify each expression.

   _____

   _____

   _____

   _____

2. What rule for exponents can you determine for each pair?

Number and Operations

Set 1: Operations with Numbers

Station 2

You will be given 12 index cards with the following numbers written on them:

$\frac{32}{4}$	$\lvert -5 \rvert$	1.44×10^2	2^3	$\sqrt{25}$	$\sqrt{7}$
12^2	$\frac{4}{5}$	$\sqrt{64}$	80%	5^1	$7^{\frac{1}{2}}$

Work with other students to group the cards that show equivalent numbers. After you have grouped the cards, work together to check that the numbers in each group are equal.

1. Write five statements that use the equals sign(s) (=) to list the groups of equal numbers.

   _____

   _____

   _____

   _____

   _____

2. For each group of numbers, write a new number that is equivalent to the group of numbers.

   _____

   _____

   _____

   _____

   _____

Number and Operations

Set 1: Operations with Numbers

Station 3

Below is an acronym to help you remember the order of operations for real numbers.

> PEMDAS
> Parentheses, Exponents, Multiplication and Division, Addition and Subtraction

You will be given an index card that has "PEMDAS" written on it to help you remember the order of operations. Work as a group to use the order of operations in order to simplify the following real number expressions. Write each operation step by step and give the operation used. The first step of problem 1 is done for you. *Hint*: Absolute value calculations are performed at the same time as parentheses.

1. $2 + 10 \bullet 3$

   Step 1: $10 \bullet 3 = 30$ Operation: Multiplication

   Step 2: _____ Operation: _____

   Final answer: _____

2. $|-10| - 14 \bullet 2$

   Step 1: _____ Operation: _____

   Step 2: _____ Operation: _____

   Step 3: _____ Operation: _____

   Final answer: _____

3. $30 - 10 \div 5$

   Step 1: _____ Operation: _____

   Step 2: _____ Operation: _____

   Final answer: _____

4. $3 + 5^2 - (10 \bullet 2)$

   Step 1: _____ Operation: _____

   Step 2: _____ Operation: _____

   Step 3: _____ Operation: _____

   Step 4: _____ Operation: _____

   Final answer: _____

Number and Operations

Set 1: Operations with Numbers

Station 4

You will be given 12 index cards with the following expressions and integer values of variables written on them:

$2x + 10$	$\frac{3}{4}y$	$b^2 + 10$	$5d^2 + 2d - 1$	$\frac{(z-3)^2}{5}$	$\frac{7t^3}{2t^4}$
$z = 10$	$b = 5$	$x = 3$	$t = 2$	$y = 8$	$d = 2$

Work as a group to simplify each expression using the appropriate variable.

1. Simplify each expression using the given value of the variable. Write your answers below.

   _____

   _____

   _____

   _____

   _____

2. What happens to each expression if you change each variable to its opposite?

   ($z = -10$, $b = -5$, $x = -3$, $t = -2$, $y = -8$, $d = -2$)

3. Do any of the new simplified expressions have the same value as in problem 2? Why or why not?