PBS Lesson Series

Math: Grade 8, Lesson 2, Expressions & Equations

Lesson objective: Students will write equations using symbols with a focus on identifying linear and nonlinear expressions in *x*.
Lesson Focus: Identifying Linear and Nonlinear Expressions in *x*
Practice Focus: Writing expressions using symbols and identifying linear and nonlinear expressions in *x*
TN Standard: 8.EE.C.7
Key Vocabulary:

- Equation in *x*
- Expressions in *x*
- Constant
- Power of *x*
- Linear expressions
- Non-linear expressions

Teacher Video Materials:

- Whiteboard & markers

Student Materials:

- Paper and writing utensil or other notetaking device
- Student packet for math, grade 8 lesson 2, which can be found at www.tn.gov/education
- No calculator required

Teacher Do	Student Do
<u>Opening</u> **Hello! Welcome to Tennessee's At Home Learning Series for math! Today's lesson is for all our 8th graders out there, though all children are welcome to tune in. This lesson is the second in our series.** **My name is ____ and I'm an ____ grade teacher in Tennessee schools! I'm so excited to be your teacher for this lesson! Welcome to my virtual classroom!** **Today we will be learning about Equations and Expressions and reviewing Writing Equations Using Symbols! Before we get started, to participate fully in our lesson today, you will need:** • **Paper and a writing utensil or another notetaking device** • **Student packet for math, grade 8 lesson 2, which can be found at www.tn.gov/education** • **No calculator needed today!** **If you didn't see our previous lesson, you can find it on www.tn.gov/education. You can still tune in to today's lesson if you haven't seen any of our others, but it might be more fun if you first go back and watch our other lessons since we'll be talking about things we learned previously.** **Ok, let's begin!**	Students get materials ready for the lesson

Intro

Today we are going to working on Linear and Nonlinear Expressions. You will know the properties of linear and nonlinear expressions in *x*, and you will transcribe and identify expressions as linear or nonlinear. Let's get started with some vocabulary and key points for today:

[Teacher writes or shows on the board.]

- **A symbolic statement in *x* with an equal sign is called an equation in *x*. The equal sign divides the equation into two parts, the left side and the right side. The two sides are called expressions.**
- **For the sake of simplicity, we will only discuss expressions in *x*, but know that we can write expressions in any symbol or variable.**
- **Linear expressions in *x* are special types of expressions. Linear expressions are expressions that are sums of constants and products of a constant and *x* raised to a power of 0, which simplifies to a value of 1, or a power of 1.**
- **Nonlinear expressions are also sums of constants and products of a constant and a power of *x*. However, nonlinear expressions will have a power of *x* that is not equal to 1 or 0.**

Students review the vocabulary and examples.

Now, let's look at some samples. The expressions in red are all variations of LINEAR equations. The expressions in black are all NONLINEAR equations. Check these against your definitions.

[Teacher writes or shows these on the board].

Students answer the question.

$5x + 3$	$-8x + \frac{7}{9} - 3$	
$4x^2 - 9$	$0.31x + 7 - 4.2x$	
$11(x + 2)$	$-(6 - x) + 15 - 9x$	

Let's look closer at two expressions:
$5x + 3$ and $4x^2 - 9$.
The first one is linear, and the second one is nonlinear. What is the biggest difference? [Pause]

Student decides what the difference is.

Did you say that the power of one term in the second expression was not 1 or 0? If so, then you are right!

The reason we want to be able to distinguish linear expressions from nonlinear expressions is because we will soon be solving linear equations. Nonlinear equations are a set of equations you learn to solve in high school mathematics, though we begin to solve simple nonlinear equations later. We also want to be able to recognize linear equations in order to predict the shapes of their graphs, which is a concept we learn more about in later lessons.

Here are some more things to remember: You might want to write these down. [teacher write or show while reading] • **Terms are any product of an integer power of *x* and a constant, or just a constant.** • **Constants are fixed numbers.** • **When a term is the product of a constant and a power of *x*, the constant is called a coefficient.**	
Teacher Model [5 examples] **Follow along as we work through several examples. We are going to answer the following about each expression:** [Teacher writes or shows.] • **How many terms in the expression?** • **What are the terms in the expression?** • **Can the expression be simplified?** • **Is the expression linear or nonlinear expression in *x*? Why?** **Let's look at Example 1a. [**Teacher writes the expression, reads each question, and writes the response.] **$57 - x$** • **How many terms?** [Pause.] **two** • **What are the terms? [**Pause.] **57 and $-x$** • **Can it be simplified?** [Pause.] **No, no like terms to combine** • **Is the expression linear or nonlinear?** [Pause.] **Linear because the terms are a constant (57) and the product of a constant and *x* which are -1 and *x*.** **Let's look at Example 1b: [**Teacher writes the expression, reads each question, and writes the response.] **$2x^2 + 9x + 5$** • **How many terms?** [Pause.] **Three** • **What are the terms?** [Pause.] **$2x^2$ and $9x$ and 5** • **Can it be simplified?** [Pause.] **No, no like terms to combine** • **Is the expression linear or nonlinear?** [Pause.] **Nonlinear because the term $2x^2$ has an exponent/power that is not 1 or 0.** **Let's look at Example 2: [**Teacher writes the expression, reads each question, and writes the response.] **$4 + 3x^2$** • **How many terms?** [Pause.] **Two** • **What are the terms?** [Pause.] **4 and $3x^2$** • **Can it be simplified?** [Pause.] **No**	Students follow along writing their ideas on their own paper or notetaking device during the examples. Students answer. Students answer. Students answer. Students may copy or just watch and think about the responses. Students answer. Students answer. Students answer. Students answer. Students answer. Students answer.

• **Is the expression linear or nonlinear?** [Pause.] **Nonlinear, exponent/power other than 1 or 0.** **Let's look at Example 3.** [Teacher writes the expression, reads each question, and writes the response.] **7*x* + 9 + 6 + 3x** • **How many terms?** [Pause.] **Four as it is currently.** • **What are the terms?** [Pause.] **7*x* and 9 and 6 and 3*x*.** • **Can it be simplified?** [Pause.] **Yes, combine like terms to 10*x* + 15** • **Is the expression linear or nonlinear?** [Pause.] **Linear because no term has a power of *x* other than 1 or 0.** Let's add a couple more questions to this one. • **What terms have coefficients?** [Pause.] **7*x* and 3*x* in the original expression. 10*x* in the simplified expression.** **Let's look at Example 4.** [Teacher writes the expression, reads each question, and writes the response.] **5 + 9*x* · 7 + 2x^9** • **How many terms?** [Pause.] **Three terms (Remember terms are separated by a plus or minus.]** • **What are the terms?** [Pause.] **5 and 9*x* · 7 and 2x^9** • **Can it be simplified?** [Pause.] **Yes, 9x · 7 can be simplified to 63*x*, so the expression can be written as 5 + 63*x* + 2x^9** • **Is the expression linear or nonlinear?** [Pause.] **Nonlinear because the term 2x^9 has a power of x other than 1 or 0.** • **Which terms have coefficients?** [Pause.] **9*x* · 7 and 2x^9 in the original expression. 63*x* and 2x^9 in the simplified expression.** **Example 5 is a little trickier. Let's see what's different here. [**Teacher writes the expression, reads each question, and writes the response.] **94 + *x* + 4x^{-6}** • **How many terms?** [Pause.] **Three terms** • **What are the terms?** [Pause.] **94 and *x* and 4x^{-6}** • **Can it be simplified?** [Pause.] **No, because there are no like terms to combine.** • **Is the expression linear or nonlinear?** [Pause.] **Nonlinear because the term 4x^{-6} has a power of *x* other than 1 or 0. Negative exponents show up in expressions some times.** **Whew! That was a lot of examples!**	Students answer. Students answer. Students answer. Students answer. Students answer. Students answer. Students answer. Students answer. Students answer. S
<u>Guided Practice</u> **Now, let's incorporate some of our skills in writing expressions in symbols along with determining if the expression is linear or not**	

linear. Don't forget to define the variable first! You try these on your own first. **Write each of the following statements in Exercises 1–5 as a mathematical expression. State whether or not the expression is linear or nonlinear. If it is nonlinear, then explain why.** [Teacher writes or shows all five problems.] **I'll give you some time to work. You can also pause the video.** **1. The sum of a number and four times the number.** **2. The product of five and a number.** **3. Multiply six and the reciprocal of the quotient of a number and seven.** **4. Twice a number subtracted from four times a number, added to 15.** 5. **The square of the sum of six and a number**. [Pause, then show solutions.] **Check your work. [teacher write or show all five solutions]** **For all Let *x* be a number:** **1. *x* + 4*x*; simplified to 5*x*; Linear – no term has power of *x* other than 1 or 0** **2. 5*x*; linear – no term has power of *x* other than 1 or 0** **3. 6 · 7/*x*; nonlinear because 7/x is rewritten as $7 \cdot x^{-1}$ which is a power other than 1 or 0.** **4. 15 + (4*x* – 2*x*); simplified to 15 + 2*x*; linear – no term has power of *x* other than 1 or 0.** **5. $(x+6)^2$; simplified to $x^2 + 12x + 36$; nonlinear: x^2 has a power of *x* other than 1 or 0.** **How did you do? Great!**	Students should write the expression in symbols on their paper and determine whether it is linear or nonlinear. Check work against teacher responses.
<u>Independent Practice</u> **Let's recap what we've worked on today and a summary of the lesson:** • **We have definitions for linear and nonlinear expressions.** • **We know how to use the definitions to identify expressions as linear or nonlinear.** • **We can write expressions that are linear and nonlinear.** • **A linear expression is an expression that is equivalent to the sum or difference of one or more expressions where each expression is either a number, a variable, or a product of a number and a variable.** • **A linear expression in x can be represented by terms whose variable x is raised to either a power of 0 or 1. For example, 4+3*x*, 7*x*+*x*-15, and 1/2 *x*+7-2 are all linear expressions in *x*. A nonlinear expression in *x* has terms where x is raised to a power that is not 0 or 1. For example, $2x^2$-9, $-6x^{-3}$+8+*x*, and 1/*x*+8 are all nonlinear expressions in *x*.**	Students write or listen to the closing points.

Let's complete your Exit Ticket for Today's Lesson: **Try these two on your own.** [Teacher writes or shows both.] **Write each of the following statements as a mathematical expression. State whether the expression is a linear or nonlinear expression in *x*.** • **Seven subtracted from five times a number, and then the difference added to nine times a number** • **Three times a number subtracted from the product of fifteen and the reciprocal of a number** [Pause.] **Here are the answers!** [Teacher writes or shows both.] • **Let *x* be a number. $(7 - 5x) + 9x$ is linear because no term has a power other than 0 or 1.** • **Let *x* be a number. $3x - 15(1/x)$ is nonlinear because the reciprocal of a number $(1/x)$ can be rewritten as x^{-1} which is a power other than 1 or 0! That was a little tricky too!** **You can now complete the Problem Set for Math: Grade 8 Lesson 2 if you want some additional practice.**	Students complete Exit Ticket. Student complete the Problem set for Math: Grade 8 Lesson 2.
<u>Closing</u> • **I enjoyed doing some mathematics with you today! Thank you for inviting me into your home. I look forward to seeing you in our next lesson in Tennessee's At Home Learning Series!** • **Bye!**	

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