Building Concepts: What is a Variable?

TEACHER NOTES

Lesson Overview

Algebraic Focus: Why are variables important?

In this lesson students evaluate expressions, write expressions that correspond to given situations, and use expressions and formulas to solve problems. Students also examine a product of the form *ax* for given integer values of *a* in terms of how the value of the product changes for a one unit change in *x*, laying an informal foundation for rate of change and slope in later work.

A variable might stand for a range of numbers that can be used in a mathematical expression; a variable might be used in a universal statement that is true for all numbers; or a variable might stand for a specific value such as the solution to an equation or word problem.

Learning Goals

1. Understand that a variable can take on any one of a range of values;
2. recognize an algebraic expression as one involving some combination of variables, numbers and mathematical operations;
3. identify a constant expression as an expression that does not contain a variable;
4. recognize that the units in the information about a problem can help in making sense of the problem.

Prerequisite Knowledge

What is a Variable? is the second lesson in a series of lessons that explore the concept of expressions. This lesson builds on the concepts of the previous lesson. Prior to working on this lesson students should have completed *What is an Exponent?* Students should understand:

- the distributive property;
- the concept of multiplication;
- the concept of negative rational numbers.

Vocabulary

- **expression:** a phrase that represents a mathematical or real-world situation
- **variable:** a letter that represents a number in an expression
- **constant:** an expression that does not contain a variable

Lesson Pacing

This lesson should take 50–90 minutes to complete with students, though you may choose to extend, as needed.

Lesson Materials

- Compatible TI Technologies:

  TI-Nspire CX Handhelds, TI-Nspire Apps for iPad®, TI-Nspire Software

- What is a Variable_Student.pdf
- What is a Variable_Student.doc
- What is a Variable.tns
- What is a Variable_Teacher Notes
- To download the TI-Nspire activity (TNS file) and Student Activity sheet, go to http://education.ti.com/go/buildingconcepts.

Class Instruction Key

The following question types are included throughout the lesson to assist you in guiding students in their exploration of the concept:

Class Discussion: Use these questions to help students communicate their understanding of the lesson. Encourage students to refer to the TNS activity as they explain their reasoning. Have students listen to your instructions. Look for student answers to reflect an understanding of the concept. Listen for opportunities to address understanding or misconceptions in student answers.

Student Activity: Have students break into small groups and work together to find answers to the student activity questions. Observe students as they work and guide them in addressing the learning goals of each lesson. Have students record their answers on their student activity sheet. Once students have finished, have groups discuss and/or present their findings. The student activity sheet can also be completed as a larger group activity, depending on the technology available in the classroom.

Deeper Dive: These questions are provided to facilitate a deeper understanding and exploration of the content. Encourage students to explain what they are doing and to share their reasoning.

Mathematical Background

A mathematical *expression* is a phrase about a mathematical or real world situation. A mathematical expression can have one operation or a series of operations or be just a single number. Numerical expressions express numerical calculations using numbers. Algebraic expressions specify numerical calculations using numbers and letters or symbols standing for numbers. Letters standing for numbers in an expression are called *variables*. Depending on the context, a variable can be used in different ways. A variable might stand for a range of numbers that can be used in a mathematical expression; a variable might be used in a universal statement that is true for all numbers such as stating the commutative property, $ab = ba$ for all real numbers a and b; or a variable might stand for a specific value such as the solution to an equation or word problem. In grade 6, students leave behind the symbol "$\times$" for multiplication and come to understand that the juxtaposition of a number and a variable such as $3x$ implies multiplication between 3 and x.

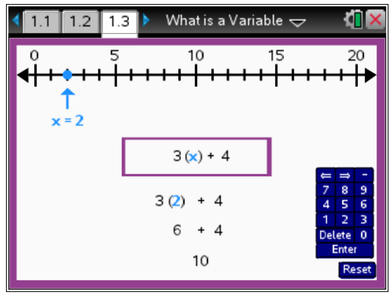
The meaning of a variable and its associated units should be clear from the context of a problem, i.e., "let t stand for the length of the smallest side of a triangle in inches". In this lesson students evaluate expressions, write expressions that correspond to given situations, and use expressions and formulas to solve problems. Students should think about the units as they set up their problem. For example, if x represents the number of pieces of fruit and each piece of fruit costs $3, the product $3x$ represents ($3 per piece of fruit) (x pieces of fruit) and will produce an answer in dollars.

Students also examine a product of the form ax for given integer values of a in terms of how the value of the product changes for a one unit change in x, laying an informal foundation for rate of change and slope in later work. The first part of the lesson involves using a number line with positive values from 0 to 20. The second part of the lesson extends the number line to -10 to 10, and can be used if students have some awareness of negative rational numbers. The lesson briefly touches on the fact that expressions in different forms can be equivalent, and the distributive property is one way to rewrite expressions in equivalent forms.

Note: the questions in parts 1 – 3 are designed for students without experience with negative integers. Operations with signed numbers are in Grade 7, so in this lesson the initial focus is on expressions that do not involve negative rational numbers. If students have had experience with negative integers, the questions in part 4 can be used with pages 2.2 and 2.3, where the number line goes from -10 to 10.

Part 1, Page 1.3

Focus: Students explore the definitions of *variable*, *expression*, and *constant*.



On page 1.3, the dot on the number line can be moved using the arrow keys on the keypad, on the screen and on the handheld or by using the keypad to select and drag.

Numbers changes the numbers in the boxed expression by typing a new value over the selection.

Operation can be used to change the operation.

Use the arrow keys to move the point on the number line.

The possible values for the variable on page 1.3 are whole numbers from and including 0 to 20.

TI-Nspire Technology Tips

[menu] accesses page options.

[tab] selects the multiplier or constant.

[+], [−] changes the operator.

[ctrl] [del] resets the page.

Class Discussion

The following questions are designed to establish the definitions of variable, expression, and constant. The variable used in the expressions in the file is x. You might want to point out that any letter could be used in the expressions; the files just happen to use x.

Have students…	**Look for/Listen for…**
Move the dot on the number line to $x = 0$***.***	
• ***What is the value of*** $3x + 4$ ***when*** $x = 0$***?***	Answer: 4
• ***What operation is implied between 3 and the value of x?***	Answer: Multiplication or 3 times *x.*
• ***What value of x makes the value of the expression equal to 16?***	Answer: $x = 4$
Which of the following is true?	
• ***As x increases, the value of*** $3x + 4$ ***decreases.***	Answer: False, the value of $3x + 4$ increases.

Class Discussion (continued)

- ***As x increases, the value of $3x+4$ increases.*** Answer: True.
- ***The value of $3x+4$ is always even.*** Answer: False, the value of $3x+4$ is odd if x is an odd number.
- ***The value of $3x+4$ will be a multiple of 10 at least once.*** Answer: True, at $x=2$ and 12. Other values will also work but are not among the values on the number line that can be used to replace the variable in this problem.

Change each as indicated. Then describe the change in value as x increases by 1. Use the file to check your thinking.

- ***Describe the change in the value of $3x+4$.*** Answer: The value increases by 3.
- ***Change the 4 to 6 and describe the change in the value of $3x+6$.*** Answer: The value increases by 3.
- ***Change the 3 to a 5 and describe the change in the value of $5x+4$.*** Answer: The value increases by 5.
- ***Describe the expression if the value changes by 2.*** Answer: The expression will be 2x plus any constant.

In each case, make a conjecture about how the value will change as x increases by 1. Create the expression and check using the file.

a. $5x+3$ b. $8x+4$

c. $0x+9$ d. $x-5$

Answers: a) increase by 5; b) increase by 8; c) does not change so changes by 0; d) increase by 1.

The addition and multiplication problem in the box on page 1.3 is called an <u>expression</u>: a phrase describing mathematical calculations using some combination of numbers, letters and operations. The x in the expression is called a <u>variable</u>, and it can be replaced by any value from a range of numbers.

- ***What values can be used for x on page 1.3?*** Answer: x can take on the value of any whole number from 0 to 20.
- ***Which of the following are expressions? Explain your thinking in each case.***

  a. $2x$ b $2x-5$

  c. $3x+5$ d. $\frac{x}{3}$

  Answer: They are all expressions because they all contain a combination of numbers, letters and operations.

Class Discussion (continued)

A <u>constant</u> is an expression that does not contain a variable.

- ***Give an example of an expression that is constant and one that is not.***
  Answer: Any number by itself could be a constant, i.e., 7; an expression like $3x$ or $x+5$ or x will not be a constant.
- ***Penny says that the value of a constant expression will always be the same. Do you agree with Penny? Why or why not?***
  Answer: Penny is correct because the value will always be whatever the number is; without a variable there is nothing to change.
- ***How can you create an expression that has a constant value using the file?***
  Answer: Make the multiplier of x a 0.

> **Teacher Tip:** In the following question, the expressions involve subtraction. Depending on the class, students might be asked to write the inequalities symbolically.

Reset the page. Change the operation to subtraction and create the expression $25x-12$.

- ***If x is a whole number between 1 and 20, for what values of x will the expression $25x-12$ be greater than 313?***
  Answer: For $x=14$, 15, 16, 17, 18, 19, 20 or $14 \le x \le 20$ for x a whole number.
- ***For what whole numbers between 1 and 20 for x will $25x-12$ be less than or equal to 438?***
  Answer: All whole numbers from and including 1 to 18 or $1 \le x \le 18$.
- ***For what whole numbers will the value of the expression $25x-12$ be greater than 313 and less than or equal to 438?***
  Answer: For $x=14$, 15, 16, 17, 18.

Student Activity Questions—Activity 1

1. Create an expression that satisfies each condition.

a. the value of the expression will always be a multiple of 4.

Answers will vary. $4x+8$; $8x+4$, … will always have a value that is a multiple of 4.

b. the value of the expression is always a multiple of 10.

Answers will vary: $10x$, $10x+10$, $20x+20$, … will always have a value that is a multiple of 10.

c. the value of the expression is the same as the variable.

Answer: The expression $1x+0$ will have a value equal to x.

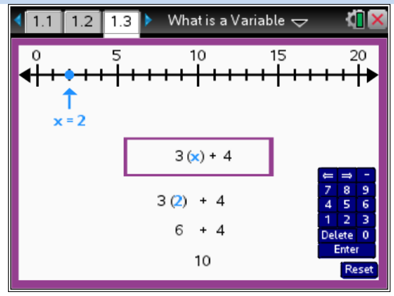
d. the value of the expression will be always be equal to 15.

Answer: The expression $0x+15$ will always have a value equal to 15.

Part 2, Page 1.3

Focus: Students create and evaluate an expression for a relationship expressed in a context.

While continuing to work on page 1.3 students build upon their understanding of *variable*, *expression*, and *constant*, introduced in Part 1.



Class Discussion

> **Teacher Tip:** The following questions ask students to create a given expression for the relationship expressed in a context, generate a set of values for the expression using the file, and then use these values to decide whether the expression is a good representation of the problem. Reasoning from a set of possible results is intended to help students see if an expression makes sense.
>
> For example: if the cost is \$20 per ticket, is it reasonable to have the cost of several tickets be \$5? The emphasis should be on the fact that the problem is in context and that the variable represents a number (the quantity) of something. In a context, units such as dollars or inches are involved, and these are important in making sense of the way an expression is set up to represent a situation.

One ticket at the school raffle costs 25 cents.

- ***What would two tickets cost?***

  Answer: 50 cents

- ***Create an expression that will show what any number of tickets from 0 to 20 will cost. Use the file to find the cost of 17 tickets***.

  Answer: $25(x)+0$. The cost would be multiples of 25 cents up to 500 cents or \$5.00. 17 tickets would cost $25(17)=425$ cents or \$4.25

- ***As the number of tickets increases by 1, what is the change in the cost of the tickets?***

  Answer: The cost increases by 25 cents.

Class Discussion (continued)

The cost for a yearly membership in Book Club A is $10, downloading a book costs $2, x represents the number of books downloaded.

- ***Evaluate at least three different values for the variable in each expression using the file. Use the results to decide which expression best represents the cost of buying books from Book Club A. Explain what is incorrect about those that do not work.***

  a. $x+10$ **b.** $10x+2$

  c. $2x+10$ **d.** $2x$

Answers may vary. a) As you continue to download books, $x+10$ gives the costs like $11, $12 and $13 that change by $1, which do not make sense given that it costs $2 per downloaded book. It also does not make sense because the outcome is supposed to be cost, a dollar amount, but $x+10$ would be adding $10 to a number of books.

b) For one book, the expression makes sense, $12, but as you continue to download more books, $10x+2$ gives costs like $22 for downloading two books, $32 for downloading three books, which are way more than what it should cost if each book is only $2 to download.

c) As you download books, $2x+10$ gives costs like $12, $14, $16—all of which make sense if each download costs $2. The units also make sense.

d) As you download books, $2x$ gives costs like $2, $4, $6, where the units make sense, but the cost is too small because the expression does not count the $10 for membership.

Student Activity Questions—Activity 2

1. The cost for a yearly membership in Book Club A is $10, downloading a book costs $2, *x* represents the number of books downloaded. Enter an expression for the cost of buying books through Book Club A. Check your answers with the file.

a. How much will it cost if you download 13 books in a year?

Answer: $36

b. Suppose you could only spend up to $50. How many books could you download?

Answer: 20 books

c. Book Club B offers a membership for only $5 but charges $3 a book. Enter the expression for buying books through Book Club B and use it to figure out which book club would be a better deal.

Answer: The new expression would be $3x+5$. If you buy 5 books, the cost for the two clubs is the same, $20, but if you buy more than 5 books, Book Club A will be less expensive.

Student Activity Questions—Activity 2 (continued)

2. Suzie has 5 more than twice as many marbles as Sam.

a. If *x* represents the number of marbles Sam has, which of the expressions makes sense for the number of marbles Suzie has. Create the expressions and check your thinking using different values for the variable. $2x+5$, $5x+2$, $2x-5$, $x+7$

Answer: The expression $2x+5$ makes sense for the number of marbles for Suzie (5, 7, 9, …), and, because she has 5 more than Sam, she could start with 5; then for every marble Sam has, she has double that amount plus 5.

b. Use your answer from part a to find the number of marbles Suzie has when Sam has 12 marbles.

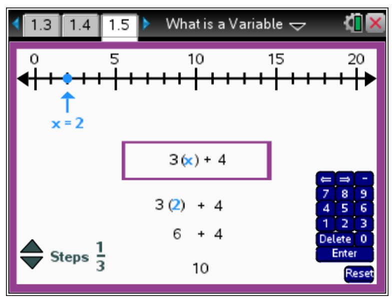
Answer: Suzie has 29 marbles.

c. How many marbles does Sam have if Suzie has 35 marbles?

Answer: Sam has 15 marbles.

Part 3, Page 1.5

Focus: Students reason about positive rational numbers in expressions, in particular about the how such numbers affect the value of different expressions.



Page 1.5 functions in a similar way to page 1.3.

Steps changes the variable in fractional increments.

Numbers changes the numbers in the boxed expression by typing a new value over the selection.

Operation can be used to change the operation.

Use the left and right arrow keys to move the point on the number line. Use the up and down arrow keys to change the steps.

The possible values on page 1.5 are fractions $\frac{a}{b}$ where *b* is a whole number from 1 to 12 and $\frac{a}{b}$ is from 0 to 20.

TI-Nspire Technology Tips

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tab selects the multiplier or constant.

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Class Discussion (continued)

Have students…	Look for/Listen for…
Move the dot, which represents the value of x, along the number line.	
• ***How have the possible values for x changed from the previous page?***	Answer: *x* can now be any value that is $\frac{c}{3}$ where *c* is a whole number (*c* many copies of $\frac{1}{3}$) between 0 and 20.
• ***Move the dot to $1\frac{2}{3}$. Explain why the product of 3 and $1\frac{2}{3}$ is 5.***	Answer: $3\left(1+\frac{2}{3}\right)=3+3$ sets of $\frac{2}{3}=3+2=5$; or another way to think is that $1\frac{2}{3}$ is the same as $\frac{5}{3}$ and $3\left(\frac{5}{3}\right)=5$.
• ***What value of x will produce a value for the expression greater than 23?***	Answer: Any value of $x>6\frac{1}{3}$
• ***Tania claims that the value of the expression $3x+4$ will always be a whole number when the step increment is $\frac{1}{3}$. Do you agree or disagree with her? Explain your reasoning.***	Answer: Yes, because the value of *x* is multiplied by 3, and the scale on the number line goes in increments of $\frac{1}{3}$. So each time the product of 3 and a mixed number with the fraction $\frac{1}{3}$ or $\frac{2}{3}$ will be a whole number, and the product of 3 and a whole number is a whole number.
Let x represent the number of feet. Write an expression to convert feet to inches. Use your expression to answer each of the following. Adjust the scale as needed and use the file to check your thinking.	
• ***How many inches tall is a $6\frac{1}{2}$ foot person?***	Answer: 78 inches tall
• ***How long in inches is a board that is $8\frac{3}{4}$ feet long?***	Answer: 105 inches
• ***Suppose you measured the length of a box in eighths of a foot and found the box to be $52\frac{1}{2}$ inches long. How long was the box in feet?***	Answer: $4\frac{3}{8}$ feet

Student Activity Questions—Activity 3

1. **Reset page 1.5 and change Steps to $\frac{1}{2}$.**

   a. **What is the value of the expression when $x = 3\frac{1}{2}$?**

   Answer: $14\frac{1}{2}$

   b. **Explain why $3\left(3\frac{1}{2}\right) = 10\frac{1}{2}$.**

   Answer: $3\left(3+\frac{1}{2}\right) = 9+\frac{3}{2}$ which is $9+1\frac{1}{2}$ or $10\frac{1}{2}$.

   c. **Change the 3 to a number so all of the values of the expression will be whole numbers. Explain your reasoning.**

   Answer: The product of any even number and $\frac{1}{2}$ will be a whole number, so you can use any even number instead of the 3.

2. **If *x* stands for the number of feet, write an expression to convert feet to inches. Check that your expression makes sense in the context by finding each of the following and thinking about whether the answers are reasonable.**

   a. 1 foot **b. 3 feet** **c. $5\frac{7}{12}$ feet** **d. $15\frac{2}{3}$ feet**

   Answer: reasons may vary: The expression 12*x* would give

   a. 12 inches, which is correct because there are 12 inches per foot.

   b. $12(3) = 36$ inches, which makes sense thinking about a ruler.

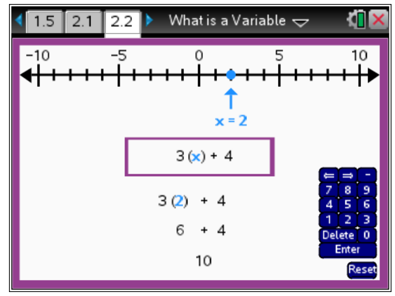
   c. 67 inches, which makes sense because 5 feet would be 60 inches and 6 feet would be 72 inches so $5\frac{7}{12}$ feet should be in between 60 and 72.

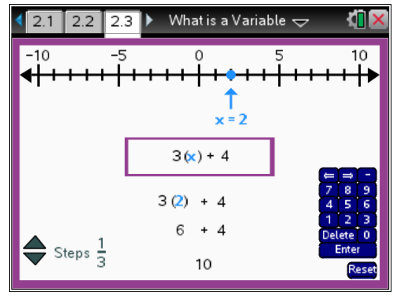
   d. 188 inches, which make sense because $15(12) = 15(10+2) = 150+30 = 180$ and $\frac{2}{3}(12) = 8$ for a total of 188 inches.

Part 4, Page 2.2–2.3

Focus: Students reason about the relationship between the numbers in an expression and the values of the expression as the variable changes from -10 to 10.

Pages 2.2 and 2.3 behave like pages 1.3 and 1.5, but the scales go from -10 to 10, which assumes students have some familiarity with negative rational numbers.





Class Discussion

- ***How is page 2.2 different from the previous pages?***

  Answer: The number line goes from -10 to 10.

- ***Is the value of the expression greater when x is -5 or when $x = 9$. Explain your reasoning.***

  Answers may vary. The expression will be greater when $x = 5$. -11 is greater than -23 because it is farther to the right on the number line.

- ***Create the expression 3x by changing the 4 to 0. Position x at 3, and move to the left one unit at a time. Describe what happens to the value of the expression when x is a negative number.***

  Answer: The value of the expression is negative because 3 multiplied by a negative number is negative. The value of the expression continues to decrease by 3.

- ***The teacher claimed that the product of a positive and negative number was a negative number. Does the file support her claim? Why or why not?***

  Answer: The file shows that $3(-1)$ is -3 and $3(-2) = 6$ and so on, so it seems to support her claim.

> **Teacher Tip:** In the following question, the variable changes in fractional increments.

Make a conjecture for each of the following, then use the file to check your conjecture.

- ***What value of x will make the expression equal 0?***

  Answer: $-1\frac{1}{3}$

Class Discussion (continued)

- ***When will the value of the expression be less than 0?***

  Answer: For any *x*-value less than $-1\frac{1}{3}$.

- ***Change the expression to $3x-4$. How will your answers to the above two questions change?***

  Answer: The first question will be $1\frac{1}{3}$ and the second question will be any *x*-value less than $1\frac{1}{3}$.

Deeper Dive – Pages 1.3–1.5

Work with a partner. One should enter the expression $2x-1$ and the other $6x-3$.

- ***Make a table of for at least six different values for the variable in your expression.***

  Answers will vary. Sample table:

x	$2x-1$	$6x-3$
1	**1**	**3**
2	**3**	**9**
3	**5**	**15**
5	**9**	**27**
10	**19**	**57**
11	**21**	**63**

- ***Compare the two tables. Make a conjecture about the relationship between the expressions.***

  Answer: All of the values for the expression $6x-3$ are three times the values for $2x-1$ for the same variable. It looks like $3(2x-1)=6x-3$.

- ***With your partner, find a mathematical reason to support your conjecture in the question above.***

  Answer: The distributive property of multiplication over addition.

Deeper Dive – Pages 1.3–1.5 (continued)

Kerry bought a large plant for $24 dollars and wanted to buy some smaller plants that cost $4 dollars each.

• ***Kerry is writing an expression for the cost of the plants she buys. She wants x to represent the cost. Kyle says x should represent the number of plants she is buying. Katie claims x should represent the number of small plants. Which of the three students do you think is correct? Explain why.***	Answer: Kerry is not correct because the missing value is the number of small plants. You need this to find the cost. It would be easier to use Katie's approach than Kyle's because if *x* represents the total number of plants, then when you found an answer then you would have to subtract 1 from that value to get the number of small plants, which is what is missing from the problem.
• ***Using your answer from the question above to describe x, which of the following expressions could represent how much Kerry will pay for the plants she buys? Use the file and for some values of x to check your thinking.*** $24x+4$, $4x+24$, $28x$	Answer: $4x+24$ gives values that make sense: $24 for just the large plant, $28 for the large and 1 small plant; $32 for the large and 2 small plants and so on.
• ***If Kerry spent $48, how many small plants did she buy? Explain your reasoning.***	Answer: 6 small plants because $(\$4 \text{ per plant})(6 \text{ plants})+\$24=\$48$
• ***Could Kerry ever spend exactly $65 on the plants? Explain why or why not.***	Answer: No because the amounts will always be multiples of 4 because one part is 4 (*x*) and the other is 4(6).

Deeper Dive – Pages 2.2–2.3

Create an expression for each condition. Use the file to help your thinking.

• ***For values of x from*** -10 ***to 10, the value of your expression will always be negative.***	Answers will vary. $3x-80$ will produce values less than 0.
• ***For values of x from*** -10 ***to 10, the value of your expression will always be positive.***	Answers will vary. $3x+80$ will produce values greater than 0.
• ***The value of the expression will be a constant less than 0.***	Answers will vary. $0x-2$ will produce -2 for every value of *x*.

Suppose the class bought baking supplies to make brownies for a bake sale and spent $12. They sell the brownies for $4 for a pan of brownies.

Deeper Dive – Pages 2.2–2.3 (continued)

- ***Create an expression to describe how much money they will make if they sell x pans of brownies.***

  Answer: $4x - 12$

- ***Suppose they sell $2\frac{1}{2}$ pans of brownies. What does your expression give for the cost? Explain why or why not.***

  Answer: $4\left(2\frac{1}{2}\right) - 12 = -2$; they are still $2 behind what it cost to buy the supplies.

- ***How many pans of brownies would they have to sell to break even?***

  Answer: $4x - 12 = 0$ when they sell 3 pans of brownies.

- ***How much money would they make if they sell $8\frac{1}{2}$ pans of brownies?***

  Answer: $22.

Sample Assessment Items

After completing the lesson, students should be able to answer the following types of questions. If students understand the concepts involved in the lesson, they should be able to answer the following questions without using the TNS activity.

1. A car can seat *c* adults. A van can seat 4 more than twice as many adults as the car can. In terms of *c*, how many adults can the van seat?

   a. $c+8$ b. $c+12$ c. $2c-4$ d. $2c+4$ e. $5c+2$

   NAEP grade 8, 2013

   Answer: d. $\mathbf{2c+4}$

2. The expression 80*n* could represent

   a. an increase of 80 cents in the cost of a candy bar that originally cost *n* cents

   b. a decrease of 80 cents in the cost of a candy bar that originally cost *n* cents

   c. the cost of each candy bar in a pack of *n* candy bars where the total cost of the pack is 80 cents

   d. the cost of each candy bar in a pack of 80 candy bars where the total cost of the pack is *n* cents

   e. the total cost, in cents, of *n* candy bars at a cost of 80 cents for each candy bar

   NAEP, Grade 8, 2013

   Answer: e. the total cost, in cents, of n candy bars at a cost of 80 cents for each candy bar

3. If $x=2n+1$, what is the value of *x* when $n=10$?

   a. 11

   b. 13

   c. 20

   d. 21

   e. 211

   NAEP, Grade 8, 2007

   Answer: d. 21

4. If $a=115$ and $b=45$, what would be the value of the expression $b+(a-b)$?

   a 115   b. 185   c. 205   d. 275

   Answer: a. 115

   Ohio grade 6, 2004

5. Archaeologists measure the lengths of certain bones to estimate a dinosaur's height. When the length L (in centimeters) of the tibia, or leg bone, is known, a dinosaur's height can be estimated by $2.5L + 73$.

   If the length of the tibia of a certain dinosaur is 400 centimeters, what is its estimated height in centimeters?

   a. 402.5

   b. 473

   c. 475.5

   d. 1,000

   e. 1,073

   Answer: e. 1,073

Adapted from NAEP, grade 8, 2013

Student Activity Solutions

In these activities you will create and use expressions with variables to solve problems. After completing the activities, discuss and/or present your findings to the rest of the class.

Activity 1 [Page 1.3]

1. Create an expression that satisfies each condition.

   a. the value of the expression will always be a multiple of 4

   Answers will vary. $4x+8$; $8x+4$, *… will always have a value that is a multiple of 4.*

   b. the value of the expression is always a multiple of 10.

   Answers will vary: 10x, $10x+10$, $20x+20$, *… will always have a value that is a multiple of 10.*

   c. the value of the expression is the same as the variable.

   Answer: The expression $1x+0$ *will have a value equal to x.*

   d. the value of the expression will be always be equal to 15.

   Answer: The expression $0x+15$ *will always have a value equal to 15.*

Activity 2 [Page 1.3]

1. The cost for a yearly membership in Book Club A is $10, downloading a book costs $2, *x* represents the number of books downloaded. Enter an expression for the cost of buying books through Book Club A. Check your answers with the file.

   a. How much will it cost if you download 13 books in a year?

   Answer: $36

   b. Suppose you could only spend up to $50. How many books could you download?

   Answer: 20 books

   c. Book Club B offers a membership for only $5 but charges $3 a book. Enter the expression for buying books through Book Club B and use it to figure out which book club would be a better deal.

   Answer: The new expression would be $3x+5$. *If you buy 5 books, the cost for the two clubs is the same, $20, but if you buy more than 5 books, Book Club A will be less expensive.*

2 Suzie has 5 more than twice as many marbles as Sam.

a. If x represents the number of marbles Sam has, which of the expressions makes sense for the number of marbles Suzie has. Create the expressions and check your thinking using different values for the variable. $2x+5$, $5x+2$, $2x-5$, $x+7$

Answer: The expression $2x+5$ makes sense for the number of marbles for Suzie (5, 7, 9, …), and, because she has 5 more than Sam, she could start with 5; then for every marble Sam has, she has double that amount plus 5.

b. Use your answer from part a to find the number of marbles Suzie has when Sam has 12 marbles.

Answer: Suzie has 29 marbles.

c. How many marbles does Sam have if Suzie has 35 marbles?

Answer: Sam has 15 marbles.

Activity 3 [Page 1.5]

1. Reset page 1.5 and change Steps to $\frac{1}{2}$.

a. What is the value of the expression when $x = 3\frac{1}{2}$?

Answer: $14\frac{1}{2}$

b. Explain why $3\left(3\frac{1}{2}\right) = 10\frac{1}{2}$.

Answer: $3\left(3+\frac{1}{2}\right) = 9+\frac{3}{2}$ which is $9+1\frac{1}{2}$ or $10\frac{1}{2}$.

c. Change the 3 to a number so all of the values of the expression will be whole numbers. Explain your reasoning.

Answer: The product of any even number and $\frac{1}{2}$ will be a whole number, so you can use any even number instead of the 3.

2. If *x* stands for the number of feet, write an expression to convert feet to inches. Check that your expression makes sense in the context by finding each of the following and thinking about whether the answers are reasonable.

   a. 1 foot b. 3 feet c. $5\frac{7}{12}$ feet d. $15\frac{2}{3}$ feet

   Answer; reasons may vary: The expression 12x would give

   a. 12 inches, which is correct because there are 12 inches per foot.

   b. $12(3)=36$ *inches, which makes sense thinking about a ruler.*

   c. 67 inches, which makes sense because 5 feet would be 60 inches and 6 feet would be 72 inches so $5\frac{7}{12}$ *feet should be in between 60 and 72.*

   d. 188 inches, which make sense because $15(12)=15(10+2)=150+30=180$ *and* $\frac{2}{3}(12)=8$ *for a total of 188 inches.*