MODULE TWO

This module addresses solving linear equations.

SC Academic Elementary Algebra Indicators included in this module are:

EA-2.4 Use dimensional analysis to convert units of measure within a system.

EA-3.6 Classify a variation as either direct or inverse.

EA-3.7 Carry out a procedure to solve literal equations for a specified variable.

EA-3.8 Apply proportional reasoning to solve problems.

EA-4.7 Carry out procedures to solve linear equations for one variable algebraically.

The resources provided in this module are not all inclusive. They are provided to begin to build the conceptual foundation students need. Additional resources will be required to develop the concepts.

The following solving linear equations activity can be used as an introductory activity or as a review activity after Lesson #1. This strategy can be adapted to use with other Elementary Algebra Lessons.

WHAT IS A JIGSAW? First, each member of the home team is assigned a topic on which to become an expert. Students with the same topic/skill will meet in expert groups to discuss and master the topic/skill. All students return to their home teams and share/teach what they learned to their team members.

EXAMPLE: A pre-assessment is given to help create heterogeneous groups based on ability level. Place students in home teams of five. Within home teams, assign each member to one of the following expert groups: one step addition and subtraction equations, one step multiplication and division equations, two step equations, simplifying expressions involving distributive property and the checker.

Students move to their expert groups. While the teacher serves as facilitator, students will be given time to help each other master the assigned skill. Each group will have a practice sheet with ONLY problems related to that skill. The checker group will have problems with answers. They learn how to verify solutions using substitution (calculators will be needed). Students should also be able to explain to their home group why they performed a certain step. Students who are having difficulty solving linear equations may be assigned to the checker group in order to build confidence. A primary goal of the activity is to give each student support and assistance.

Then students will move back to their home groups. Before they begin working, the teacher will explain and model the Cycle for Solving Equations: Distributive Property First → Two Step → One Step. If the problem doesn't have one of steps of the cycle, students move on to the next step. Later, the Cycle will be Distribute Property First → Variables on Both Sides → Two Step → One Step.

Given an equation like $2x = 7$, the group facilitator will ask for the first step to solving this equation. The one step expert will share the first step, explain why and work out the problem. Then, the checker will verify.

Problems will increase in difficulty. The goal is for each "expert" to recognize where their expertise is needed. For example, given $4(2x—3) = -8$. The distributive property expert will explain how to simplify then the two step expert will give the next step then the one step expert. The checker will verify.

<u>Later:</u> The teacher can lead the class in a discussion on how to solve an equation like $3x — 4 = -5x + 6$ by asking the two step experts "What could we do to put this equation in the two step equation format?" or "What should be eliminated in order to put this equation in the two step equation format?" Then follow the cycle.

Lesson # 1	
Topic: Solving Linear Equations	
Standards (s): EA – 4.7	

I. Planning the Lesson

The first bullet under the Continuum of Knowledge represents student's prior knowledge and/or skills needed to meet this standard. It is recommended that students are pre-assessed on this prior knowledge.

- **Continuum of Knowledge**
  - In 6^{th} grade, students solve one step linear equations with whole number solutions and coefficients (6-3.5). In 7^{th} grade, students solved two step equations and inequalities (7-3.4). In 8^{th} grade, students solved multi-step equations (8-3.4)
  - In elementary algebra, students carry out procedures to solve linear equations for one variable algebraically.
  - The process of solving linear equations is foundational for student's work with solving other types of equations such as quadratic (IA-3.3) and polynomial equations (IA-4.3) for an indicated variable.

- **Taxonomy Level**
  3-C
  Cognitive Process Dimension: Apply
  Knowledge Dimension: Procedural Knowledge

- **Key Concepts**
  Linear equation
  Solution

II. Teaching the Lesson

In this lesson, students will solve one step, two step and multi-steps linear equations as well as verify their solutions. In addition to becoming fluent in such procedures, students build a conceptual understanding of how linear equations are structured. For example, have students verbalize that the structure of the linear equation 2x – 5 = -3 is "two times some number minus five is equal to -3." This allows students to use appropriate operations to undo the structure. Students are using their prior knowledge of algebraic expressions and engaging in algebraic reasoning to solve linear equations. Presenting a real world problem whose solution is found by solving a linear equation creates purpose for the process.

- See the Resources section for an opening activity.

- **Essential Learning and Understanding**
  It is essential for students to do the following for the attainment of this indicator:
  - Use appropriate algebraic techniques to solve for a given variable.
  - Understand which algebraic techniques or properties were applied in order to get the resulting equivalent linear equation.
  - Solve linear equations involving one step, two steps, distributive property, variables on both sides, fractional coefficients, decimals and the collecting of like terms.
  - Solve linear equations that result in one solution, no solution or infinitely many solutions.
  - Check their solutions using an appropriate method.

- **Examples of Essential Tasks**
  These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

  - Solve. $-2(x-5)=3x+4$
  - Solve. $6x-x=-10$
  - Solve. $\frac{2}{3}(6x-3)=4x+1$
  - Solve. $3(x+2)=3x+4$

  - In which step did the first error occur?

$$3(2x-1)=6$$
$$Step\ 1: \quad 6x-3=6$$
$$Step\ 2: \quad 6x=3$$
$$Step\ 3: \quad x=\frac{1}{2}$$

- **Non-Essential Learning and Understanding**
  It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:
  - Solve equations involving radical notation
  - Solve rational equations with variables in the denominator that are beyond simple proportional reasoning problems.

- **Examples of Non-Essential Tasks**
  The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for

the attainment of other indicators within Elementary Algebra.

- Solve $\frac{3}{x+2}=\frac{5}{2x-1}$
- Solve $\sqrt[3]{x-2}=5$

- **Misconceptions/Common Errors**
  - Students do not fully isolate the variable. In this example, students may stop at $6x=9$ and incorrectly conclude that $x=9$

$$3(2x-1)=6$$
$$6x-3=6$$
$$6x=9$$
$$x=9$$

  - Students may misuse the equality symbol by setting up a string of equalities such as $2x+1=-5=2x=-6=x=-3$.
  - Students may have the misconception that the variable should always be on the left side of the equals sign. This can cause confusion for students when problems are presented in the form $-3=x$.

- **Technology Notes**
  - When checking their solution by direct substitution, students may use a graphing utility to verify their computations.
  - Student may check their solutions by using the intersect feature on their graphing utility. For example, given $2x+1=-5$, students would determine where the graphs of $y=2x+1$ and $y=-5$ intersect.
  - One of the difficulties students may have when using a graphing utility to determine the point of intersection is setting an appropriate viewing window that clearly displays the point of intersection. Students need sufficient practice performing this skill.
  - The table of values can also be used to verify for which x value are the y values of both equations equal. The table will need to be set in order to display the appropriate values.

III. Assessing the Lesson

Assessment Guidelines: *The objective of this indicator is for the student to carry out a procedure to solve linear equations. Therefore, the primary focus of the assessment should be for students to carry out such procedures*.

- **Assessment Item Examples**

  - Solve. $3x - 1 = 4$
    A. $x = 2$
    B. $x = \frac{5}{3}$
    C. $x = \frac{3}{5}$
    D. $x = -1$

  - Solve. $3t - t = 12$
    A. $t = -4$
    B. $t = 12$
    C. $t = -3$
    D. $t = 6$

  - Find the solution to the equation $5p + 3 = 3p + 1$.
    A. 1
    B. -1
    C. $\frac{1}{2}$
    D. $\frac{-1}{2}$

  - What is the solution for $4(x - 5) = x + 7$?
    A. $x = 9$
    B. $x = 4$
    C. $x = 13$
    D. $x = 27$

  - Find the solution to the equation $4(y - 2) = 2(y + 7)$.
    A. -11
    B. $\frac{22}{6}$
    C. 11
    D. $\frac{-22}{6}$

IV. Resources

Activity: Many students are solving linear equations without understanding what the process is. Having students, first, solve linear equations using a table of values can deepen their conceptual understanding of the process. For example, given the linear equation $2x - 5 = -1 - x$, discuss the structure of the equation. Then select values of x, create a table of values by evaluating each linear expression and analyze the table of values to determine where the two expressions are equal. Within the table, students should show the work.

X	**2x - 5**	**1 – x**
-2	2 (-2) – 5 = -9	1 – (-2) = 3
-1	2 (-1) – 5 = -7	1 – (-1) = 2
0	2 (0) – 5 = -5	1 – (0) = 1
1	2 (1) – 5 = -3	1 – (1) = 0
2	2 (2) – 5 = -1	1 – (2) = -1

So we can write that 2x – 5 = 1 – x is true when x = 1. Put students in pairs and give them other examples to work through in this manner. Then discuss how although this process is legitimate, it could be very time-consuming so algebraic methods are used.

Lesson # 2	
Topic: Solving Literal Equations	
Standards (s): EA – 3.7	

I. Planning the Lesson

The first bullet under the Continuum of Knowledge represents student's prior knowledge and/or skills needed to meet this standard. It is recommended that students are pre-assessed on this prior knowledge.

- **Continuum of Knowledge**
  - In 8th grade, students apply procedures to solve multistep equations (8-3.4).
  - In Elementary Algebra, students carry out a procedure to solve literal equations for a specified variable. (EA-3.7).
  - In Intermediate Algebra and Pre-calculus, students use this skill to solve equations with optimization problems. In Pre-calculus, students carry out a procedure to write a rule for the inverse of a function, if it exists (PC-2.9) and need to be able to solve for variables other than x and y.

- **Taxonomy Level**
  3-C
  Cognitive Process Dimension: Apply
  Knowledge Dimension: Procedural Knowledge

- **Key Concepts**
  Solving equations
  Literal equations

II. Teaching the Lesson

A literal equation is an equation that contains more than one variable. Some textbooks identify solving literal equations as solving formulas for one of its variables. In this lesson, students transfer their understanding of solving linear equations to solving literal equations. In literal equations, the letters not being solved for are treated like constants. Unlike with linear equations, the result is an algebraic expression not a numerical value. Although the process of solving literal equations is similar to solving linear equations, students may have difficulty connecting the two. Emphasizing how the two representations are different first will help students to focus on what new skills need to be added to the current process. For example, given the linear equation $2x + 5 = 4$ and the literal equation $2b + c = 4$, what are the differences? How are they similar? How would you solve for x? How would you solve for b?

- **Essential Learning and Understanding**
  It is essential for students to do the following for the attainment of *this* indicator:
  - Use inverse operations to solve literal equations for a specified variable that may involve multiple steps.

- **Examples of Essential Tasks**
  These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.
  - Solve ax = b+ cd for c.
  - P = 2l + 2w, solve for w.
  - $E = MC^2$ solve for M
  - I = PRT, solve for T
  - V = IR, solve for I
  - D = RT, solve for R

- **Non-Essential Learning and Understanding**
  It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:
  - Solve equations for a variable that requires finding roots of the equation.

- **Examples of Non-Essential Tasks**
  The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.
  - $A = \pi r^2$, solve for r.

- **Misconceptions/Common Errors**
  - Students may not isolate the variable.
  - Students may stop at an intermediate step.

- **Technology Note**
  - Solving literal equations is an essential skill for using spreadsheets for solving problems.
  - Using a spreadsheet to calculate pay with or without overtime.

III. Assessing the Lesson

Assessment Guidelines: *The objective of this indicator is for the student to* <u>*carry out*</u> *a procedure to solve literal equations for a specified variable. The solution may involve multiple steps.*

- **Assessment Item Examples**
  - The formula for converting Celsius to Fahrenheit is $F = \frac{9}{5}C + 32$. Solve this formula for C.
    - A. $C = \frac{5}{9}F + 32$
    - B. $C = \frac{5}{9}(F + 32)$
    - C. $C = \frac{9}{5}F - 32$
    - D. $C = \frac{5}{9}(F - 32)$
  - Solve $2x + 3y = 5x + 6$ for x.
    - A. $x = \frac{5x - 3y + 6}{2}$
    - B. $x = 3$
    - C. $x = y - 2$
    - D. $x = \frac{3x - 6}{7}$

Lesson # 3	
Topic: Applying Proportional Reasoning to solve problems	
Standards (s): EA – 3.8	

I. Planning the Lesson

The first bullet under the Continuum of Knowledge represents student's prior knowledge and/or skills needed to meet this standard. It is recommended that students are pre-assessed on this prior knowledge.

- **Continuum of Knowledge**
  - In 8th grade, students apply ratios, rates, and proportions (8-2.7) and use proportional reasoning and the properties of similar shapes to determine the length of a missing side (8-5.1).
  - In Elementary Algebra, students apply proportional reasoning to solve problems.
  - This essential skill is used in all subsequent study of mathematics.

- **Taxonomy Level**
  3-C
  Cognitive Process Dimension: Apply
  Knowledge Dimension: Procedural

- **Key Concepts**
  Ratio
  Proportion

II. Teaching the Lesson

In this lesson, students gain a deeper understanding of linear relationships by applying proportional reasoning to solve problems. Students are introduced to the concept of direct variation in this lesson; therefore, the components of the next lesson on indicator EA – 3.6 related to direct variation should be integrated into instruction.

- **Essential Learning and Understanding**
  It is essential for students to do the following for the attainment of this indicator:
  - Use proportional reasoning to solve problems.

- **Examples of Essential Tasks**
  These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.
  - The variables x and y vary directly and y = 35 when x = 7. Find the value of y when x = 9.

- The distance traveled by a car moving at a constant speed varies directly with the length of time it travels. If the car travels 172 miles in 4 hours, how many miles will it travel in 9 hours?
- An equation that reflects the relationship between x and y is x/y = 40. Find the value of x when y = 5.
- A statue is to be constructed using a 10:1 (height of statue:height of person) scale. If the person to be depicted is 76 inches tall, how tall should the statue be built?

- **Non-Essential Learning and Understanding**
  It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:
  - Determine the constant of proportionality for contextual, real-world problems.

- **Examples of Non-Essential Tasks**
  The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.
  - The table below shows heights of people and their arm span (distance between fingertips with arms extended perpendicular to body). Approximate the constant of proportionality and write an equation that summarizes the relationship between these two measurements, if one exists.

Height (H) in inches	**Arm span (A) in inches**
64	68
71	73
62	60
68	72
65	63

- **Misconceptions/Common Errors**
  - Some students may not know when it is appropriate to cross-multiply.

- **Technology Note**
  - Use technology where appropriate.

III. Assessing the Lesson

Assessment Guidelines: *The objective of this indicator is for the student to use proportional reasoning to solve problems.*

- **Assessment Item Examples**

  - The variables x and y vary directly and y = 20 when x = 4. Find the value of y when x = 6.

A. 24
B. 30
C. 80
D. 25

  - The circumference (c) of a circle varies directly with the radius (r) of the circle. When the radius 3, the circumference is 6π. What is the circumference (c) when the radius is 4?

A. 8π
B. 8
C. 4π
D. 4

Lesson # 4
Topic: Direct and inverse variation
Standards (s): EA – 3.6

I. Planning the Lesson

The first bullet under the Continuum of Knowledge represents student's prior knowledge and/or skills needed to meet this standard. It is recommended that students are pre-assessed on this prior knowledge.

- **Continuum of Knowledge**
  - In 7th grade, students classify relationships as either directly proportional, inversely proportional, or nonproportional. In 8th grade, students apply ratios, rates, and proportions (8-2.7) and use proportional reasoning and the properties of similar shapes to determine the length of a missing side (8-5.1).
  - In Elementary Algebra, students will classify a variation as either direct or inverse.
  - In Geometry, students use scale factors to solve problems involving scale drawings and models (G-2.6). They also apply congruence and similarity relationships among triangles to solve problems (G-3.8) and apply congruence and similarity relationships among shapes (including quadrilaterals and polygons) to solve problems (G-4.6).

- **Taxonomy Level**
  2-B
  Cognitive Process Dimension: Understand
  Knowledge Dimension: Conceptual Knowledge

- **Key Concepts**
  Direct variation
  Inverse variation

II. Teaching the Lesson

Students have prior knowledge of direct and inverse variation from 7th grade (7-3.7). In the previous lesson, students made connections between proportional reasoning and direct variation. In this lesson, students solidify their conceptual understanding of these concepts. Distance-time relationships are an effective way of illustrating inverse relationships. These relationships should be examined graphically, tabularly, verbally and algebraically to ensure conceptual understanding.

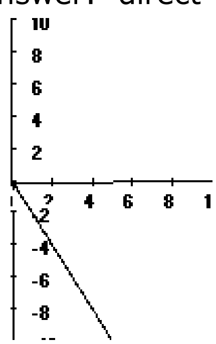
- **Essential Learning and Understanding**
  It is essential for students to do the following for the attainment of this indicator:
  - Understand the definition of direct variation
  - Understand the definition of inverse variation
  - Classify a variation as direct or inverse.

- **Examples of Essential Tasks**
  These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

  - Classify each of the following as direct variation or inverse variation.

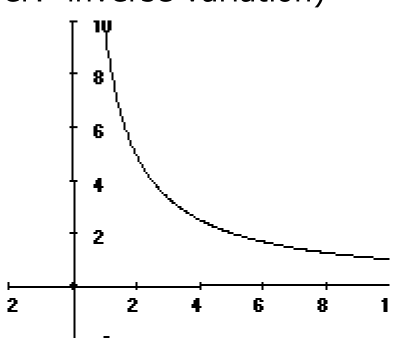
    - The circumference C of a circle and its diameter d are related by the equation C = π d.
      (Answer: direct variation)
    - XY = 20
      (Answer: inverse variation)

    - (Answer: direct variation)



- Y = 4x
  (Answer: direct variation)

- (Answer: inverse variation)



- A car is traveling at a constant speed of 50 miles/hour. The distance that the car travels is related to the time by the equation d = 50 t, where t is in hours.
  Answer: direct variation

- **Non-Essential Learning and Understanding**
  It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:
  - Write the equation for a direct variation or inverse variation

- **Examples of Non-Essential Tasks**
  The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.
  - y varies directly with x and y = 12 when x = 3. Write an equation that relates x and y.

- **Misconceptions/Common Errors**
  - Students may reverse the definitions. They may also have difficultly classifying some forms of equations.

- **Technology Note**
  Use technology where appropriate.

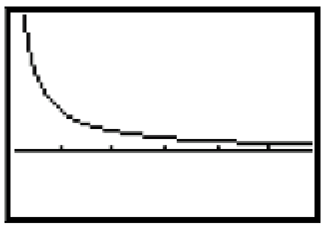
III. Assessing the Lesson

Assessment Guidelines: *The objective of this indicator is for the student to* <u>*classify*</u> *a variation as either direct or inverse. In addition to classifying variations, students should be able to exemplify, explain, or compare variations.*

- **Assessment Item Example**

  - The perimeter of a square is given in terms of the length of a side of the square as shown in the formula $P = 4s$. How does P vary with s?
    A. Inversely
    B. Directly
    C. Jointly
    D. There is no variation

- Which of the functions shows inverse variation?
  A. y = 5x
  B. y = x + 3
  C. xy = 2
  D. y = x
- Which of the following is an example of a direct variation?
  A. P = 2l + 2w
  B. $A = \pi r^2$
  C. A = lw
  D. $C = 2\pi r$



- The graph above shows
  A. Direct variation
  B. Inverse variation
  C. Joint variation
  D. A graph of all 3 types of variation

Lesson # 5
Topic: Dimensional Analysis
Standards (s): EA – 2.4

I. Planning the Lesson

The first bullet under the Continuum of Knowledge represents student's prior knowledge and/or skills needed to meet this standard. It is recommended that students are pre-assessed on this prior knowledge.

- **Continuum of Knowledge**
  - In 7th grade students use one-step unit analysis to convert between and within the U.S. Customary System and the metric system (7-5.5). In 8th grade students use multistep unit analysis to convert between and within U.S. Customary System and the metric system (8-5.7).
  - In Elementary Algebra students use dimensional analysis to convert units of measure within a system. Student understanding should exceed rote operational proficiency.
  - This essential skill is necessary in all subsequent study of mathematics.

- **Taxonomy Level**
  3-C
  Cognitive Process Dimension: Apply
  Knowledge Dimension: Procedural Knowledge

- **Key Concepts**
  Units of measure
  Conversion factor
  Dimensional analysis

II. Teaching the Lesson

Students have prior knowledge of dimensional analysis from 7th and 8th grade (7-5.5 and 8-5.7). In this lesson, students continue to build on their knowledge of dimensional analysis by converting units of measure within a system that require no more than three conversion factors.

- **Essential Learning and Understanding**
  It is essential for students to do the following for the attainment of this indicator:
  - Set up a unit conversion problem using dimensional analysis.
  - Perform calculations to convert units.

- Determine if an expression correctly converts units of measure within a system.
- Perform dimensional analysis with problems involving compound units such as mi/hr.
- Students should be able to recall the following list of conversion factors to solve dimensional analysis problems. Any other conversion factors that are required to solve the problem will be provided.

  U.S. Customary System
  - 60 seconds = 1 minute
  - 60 minutes = 1 hour
  - 24 hours = 1 day
  - 7 days = 1 week
  - 12 months = 1 year
  - 365 days = 1 year
  - 52 weeks = 1 year
  - 12 inches = 1 foot
  - 3 feet = 1 yard
  - 5,280 feet = 1 mile
  - 8 liquid ounces = 1 cup
  - 2 cups = 1 pint
  - 2 pints = 1 quart
  - 4 quarts = 1 gallon
  - 16 ounces = 1 pound

  Metric System
  - 1000 millimeters = 1 meter.
  - 100 centimeters = 1 meter
  - 1000 meters = 1 kilometer
  - 1000 milliliters = 1 liter
  - 100 centiliters = 1 liter
  - 1000 liters = 1 kiloliter
  - 1000 milligrams = 1 gram
  - 100 centigrams = 1 gram
  - 1000 grams = 1 kilogram

- *Note about Metric System: Students should understand the organizational structure of the metric system, including the meaning of prefixes, to facilitate recollection of these conversion factors.*

- **Examples of Essential Tasks**
  These examples of essential tasks are not all inclusive. They are provided to give additional clarification of possible tasks that students should be able to successfully complete.

- The mass of an object is 3.5 kg. What is the mass of the object in grams (g)?

  $3.5\,kg\,x\,\frac{1000\,g}{1\,kg} = 3{,}500\,g$

- How many pints are there in 2.75 gallons of tomato soup?

  $2.75\,gallons\;x\,\frac{4\,quarts}{1\,gallon}\,x\,\frac{2\,pints}{1\,quart} = 22\;pints$

- How many liters of gasoline are in 500 ml?

  $500\,ml\,x\,\frac{1\,l}{1000\,ml} = 0.5\,l$

- A bedroom has 11,664 square inches of floor space. How many square feet of floor space does the bedroom have?

  $\left(11{,}664\,sq\,in\,x\,\frac{1\,sq\;ft}{144\,sq\,in} = 81\,sq\;ft\right)$

- One aspirin tablet contains 375 mg of active ingredients. How many grams (g) of active ingredient are in one tablet?

  $(\,375\,mg\,x\,\frac{1\,g}{1000\,mg} = 0.375\,g\,)$

- The escape velocity from earth's surface is approximately 7.0 mi/sec. What is the escape velocity in mi/hr?

  $(\,\frac{7.0\,mi}{1\sec}\,x\,\frac{3600\sec}{1\,hr} = 25{,}200\,\frac{mi}{hr}\,)$

  or

  $(\,\frac{7.0\,mi}{1\sec}\,x\,\frac{60\sec}{1\min}\,x\,\frac{60\min}{1\,hr} = 25{,}200\,\frac{mi}{hr}\,)$

- A car is traveling at 70 miles per hour on an interstate highway. a. How many feet per second is the car traveling? b. If a football field is 300 feet long, how many football field lengths does the car travel in one second?

  a. $\frac{70\,mi}{1\,hr}\,x\,\frac{5280\;ft}{1\,mi}\,x\,\frac{1\,hr}{3600\sec} = 102.\overline{6}\;\frac{ft}{\sec}$

  b. $\frac{102.\overline{6}\;ft}{1\sec}\,x\,\frac{1\;football\;\;field\;length}{300\;ft} = 0.34\overline{2}\,\frac{football\;\;field\;lengths}{\sec}$

- Which of the following dimensional analysis expressions converts $25\ \frac{mi}{hr}$ to $\frac{ft}{\sec}$?

   a. $25\frac{mi}{hr}\ x\ \frac{1mi}{5280\ ft}\ x\ \frac{1\ hr}{60\min}\ x\ \frac{1\min}{60\sec}$

   b. $25\frac{mi}{hr}\ x\ \frac{5280\ ft}{1mi}\ x\ \frac{60\min}{1hr}\ x\ \frac{60\sec}{1\min}$

   c. $25\frac{mi}{hr}\ x\ \frac{5280\ ft}{1mi}\ x\ \frac{1hr}{60\min}\ x\ \frac{1\min}{60\sec}$

   d. $25\frac{mi}{hr}\ x\ \frac{1\ mi}{5280\ ft}\ x\ \frac{60\min}{1hr}\ x\ \frac{60\sec}{1\min}$

- **Non-Essential Learning and Understanding**
  It is not essential for students to do the following for the attainment of this indicator but could be important for the attainment of other indicators within Elementary Algebra:
  - Memorize conversion factors beyond the list provided above.
  - Convert between the U.S. Customary System and the metric system.
  - Convert units of measure that require more than three conversion factors.

- **Examples of Non-Essential Tasks**
  The examples of non-essential tasks given below are not essential for the attainment of this particular indicator but could be important for the attainment of other indicators within Elementary Algebra.
  - How many milliliters are in a gallon of gasoline?
  - How many ounces are in 10 grams?
  - If a car is traveling 55 miles per hour how many meters per second is the car traveling?

- **Misconceptions/Common Errors**
  - Students may fail to recognize that as the size of the unit changes the number of units change accordingly. For example, when converting from a larger unit to a smaller unit of measure, the number of units increases. When converting from a smaller unit to a larger unit of measure, the number of units decreases.

- Students may not realize that when a conversion factor is written as a fraction, the numerator and the denominator are equal; therefore, the fraction equals 1. Multiplying by the conversion factor, an unusual appearing 1, does not change the value but expresses the quantity in different units.
  - For example, in the conversion problem $5\, yards\, x \frac{3\ feet}{1\, yard} = 15\ feet$, the conversion factor $\frac{3\ feet}{1\, yard} = \frac{1 yard}{3\, feet} = 1$. Therefore, multiplying by 1 does not change the value, because the length is 5 yards = 15 feet. However, the size of the unit changes therefore the number of units change.

- **Technology Note**
  - Students may use technology to perform the operations of multiplication and division when evaluating expressions that are usually beyond the scope of mental calculation.

III. Assessing the Lesson

Assessment Guidelines

The objective of this indicator is to <u>use</u> dimensional analysis to convert units of measure within a system. Therefore, the primary focus of the assessment should be for students to apply such procedures to unfamiliar unit conversions within a given measurement system. To successfully use dimensional analysis to convert units, students' understanding must exceed rote operational proficiency. Students should understand the concept of dimensional analysis.

- A road is 2640 yards long. How long is the road in miles?
  ($2640\, yd\, x \frac{3\ ft}{1\, yd}\, x \frac{1 mi}{5280\ ft} = 1.5 mi$)

- A bedroom has 11,664 square inches of floor space. How many square yards of floor space does the bedroom have?
  $\left(11{,}664\, sq\, in\, x \frac{1 sq\ ft}{144\, sq\, in}\, x \frac{1 sq\, yd}{9\, sq\ ft} = 9\, sq\, yd\right)$