"Lifting" Classroom Instruction

Description

As a Kenan Fellow I spent my summer working at the Hyster-Yale Group manufacturing plant in Greenville, NC. Hyster-Yale Group produces on average about 160 lift trucks (forklifts) each day. From the engineering offices to the plant assembly line, math can be found everywhere! Every employee plays a key role in the manufacturing process including engineers, inventory managers, accountants, sales and marketing, supervisors, assembly workers, and plant managers. It is crucial that all employees in the plant work together at a consistent rate in order to ensure on-time delivery to the customer. Through this lesson students will be introduced to many different STEM careers in the industrial and manufacturing world. This unit plan contains a variety of lessons that all align to the 7th Grade Common Core Math Standards, specifically to the Ratios and Proportions domain. This plan is meant to be introduced at the beginning of the Ratios and Proportions unit, then cycled back throughout the remainder of the school year.

Introduction

The lessons in this unit will all be aligned to manufacturing careers. Students will solve real-world problems that involve critical thinking and 21st century skills. The lessons included in this unit are as follows:
  ★ Lesson 1- Introduction to Proportional Relationships
  ★ Lesson 1- Proportional Relationships within Manufacturing
  ★ Lesson 2- Demand Flow Technology (with a focus on Unit Rate)

Curriculum Alignment
  ● 7.RP.1- Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
  ● 7.RP.2- Recognize proportional relationships between quantities.
      ○ 7.RP.2.a- Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
      ○ 7.RP.2.b- Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.
      ○ 7.RP.2.c- Represent proportional relationships by equations.
      ○ 7.RP.2.d- Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.

Time & Location

Each lesson is designed for a 70 minute class period and can be taught throughout the year based on relevant pacing guides. The lessons are aligned with the 7th grade Common Core curriculum.

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Lesson #1

Introduction to Proportional Relationships

Description

Proportional relationships are found everywhere in our daily lives. These relationships can be displayed in tables and graphs, and can also be represented in an equation. Through this lesson students will be introduced to the basics of proportional relationships and how to interpret their data.

Introduction

The following lesson will cover unit rate, direct variation, constant of proportionality, and analyzing charts and graphs. This lesson will be heavy on word problems involving real-world scenarios.

Curriculum Alignment

- 7.RP.1- Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
- 7.RP.2- Recognize proportional relationships between quantities.

Objectives

- Students will be able to recognize unit rates and rate of change associated with ratios of fractions. (7.RP.1)
- Students will be able to recognize and analyze proportional relationships between quantities. (7.RP.2)

Time & Location

This lessons will last about one class period lasting 70 minutes. The lesson will take place in a regular 7th grade math classroom.

Teacher Materials

- Hyster Yale promotional video -- http://www.hyster-yale.com/hyster-yale-advantage/manufacturing/
- Promethean Board & Laptop (or other projection system)
- Around the World Problems (to be posted around the room)
- Notecards for exit ticket
- Exit ticket problem

Student Materials

- Interactive math notebooks
- Writing utensils
- Recording sheets for the Around the World

Safety

There are no potential safety hazards for this particular lesson.

Student Prior Knowledge

This lesson is towards the beginning of the Ratios and Proportions unit and will come after students complete a foldable on basic rates, ratios, and proportions. Students should have a good understanding of what each is and how to recognize them in math problems/scenarios. Students should also be able to recognize that a unit rate is a rate in terms of 1. Students should also be able to recognize equivalent fractions and how they make up a proportion.   It would also be beneficial if students are familiar with using and plotting points on a coordinate grid (data can be interpreted from a table as well). Students should also know how to utilize the "CUBES" strategy for solving word problems in mathematics.

Teacher Preparations

- Have notes prepared for students.
- Post the around the world problems around the world (use sheet protectors to protect the problems).
- Have the recording sheets printed out for students to use in the Around the World activity.
- Have the exit ticket and notecards ready and note cards for students to record their answers.

Activities

1. Introduction to Hyster Yale Manufacturing Plant
   - Show the promotional link that shows the various aspects of the Hyster Yale manufacturing plant. --- http://www.hyster-yale.com/hyster-yale-advantage/manufacturing/
2. Notes on Proportional Relationships
   - Instructor will provide two-column notes on proportional relationships. Notes will include direct variation, constant of proportionality, and charts/graphs. See attached example below.
   - Show the video clip on proportional relationships after going over the notes --- https://vimeo.com/90999587
3. "Around the World" Activity
   - Students will complete various practice problems posted around the room with a partner. The problems will include finding the constant of proportionality (k) and using it to write a direct variation equation. Students will record their answers on the provided recording sheet.
   - All problems will be based around real-world manufacturing situations.
   - The teacher should walk around and monitor student progress and assist when needed.

4. Exit Ticket
   - Instructor will post the table on the board. Students will be asked the following questions:
     - 1. Does the table show a proportional relationship?
     - 2. What is the constant of proportionality?
     - 3. Does the table show direct variation? Write the equation for direct variation if possible.

Assessments
1. Exit Ticket
   - Does the following chart show direct variation? If so, what is the Constant of Proportionality?

Critical Vocabulary
- Ratio- a comparison of two or more numbers
- Rate- a ratio comparing two numbers with different units
- Unit Rate- a comparison of two measurements in which one term has a value of 1
- Proportion- an equation showing two ratios are equal
- Direct Variation- when two two variables are related in such a way that the ratio of their values always remains the same; y=kx
- Constant of Proportionality- the constant value of the ratio of two proportional quantities x and y; represented as k
- Proportional Relationship- a relationship between two variables in which one is a constant multiple of the other
- Complex Fraction- a fraction with fractions in the numerator and/or denominator

Example

Constant of Proportionality
and
Direct variation   42

| Proportinal relationships | If the ratios of the quantities have a constant unit rate... |

(y) | Price | $0.90 | $1.05 |
(x) | pound | 1.5 | 1.75 |

divide!   =$0.60   =$0.60

yes, it is proportional!

constant of proportionality

- It has a C.O.P. if the ratios between 2 values is always the same.
- Use the variable "k" to represent it.
- You can find it from a table or graph by using the formula $k = y/x$ (unit rate)

$0.90 ÷ 1.5 = $0.60 per/lb

$k = 0.60

Direct variation

* Y varies directly as x, meaning that $y = kx$, where k is the constant of proportionality

$k = 0.60

$y = 0.60x$

![Kenan Fellows Program logo] **KENAN FELLOWS PROGRAM**
FOR TEACHER LEADERSHIP

Around the World Problems
(Click HERE to access the final product with one problem printed per page)

1. At a chair factory, the number of chairs completed can be determined by the equation c = 4w, where c is the number of chairs and w is the number of workings that are making the chair. Identify the constant of proportionality.

2. The chart below represents the weight of concrete blocks that are used in an assembly line. Determine the constant of proportionality for the table. Express your answer as a direct variation equation.

| Concrete Blocks (x)	3	8	10	6	7
weight in kilograms (y)	30	80	100	60	70

3. The chart below represents the number of paint cans used to paint birdhouses in a birdhouse manufacturing plant. Determine the constant of proportionality for the table. Express your answer as a direct variation equation.

Cans of Paint (x)	5	10	6	9	2
Bird Houses Painted (y)	15	30	18	27	6

4. The chart below represents the distance a piece of steel travels on the assembly belt while in the painting process. Determine the constant of proportionality for the table. Express your answer as a direct variation equation.

Time in minute (x)	9	2	7	3	10
Distance traveled in meters (y)	117	26	91	39	130

5. Determine the constant of proportionality of y + 2 = x.

6. Determine the constant of proportionality if 3y = x.

7. Suppose y varies directly with x, and y = 50 and x = 5. Write a direct variation equation to represent this situation.

8. Suppose y varies directly with x, and y = 16 when x = 7. Find y when x = 16.

9. What is the constant of proportionality for the graph provided?
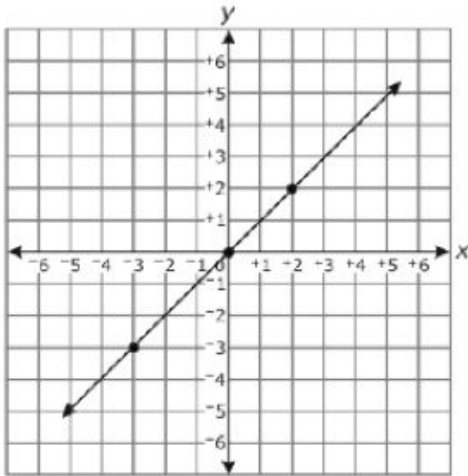
10. List two or more characteristics of a graph that represents direct variation.

11. The graph below shows the amount of money Vincent makes working at the Little Debbie factory. What is Vincent's hourly rate of pay?

Vincent's Pay
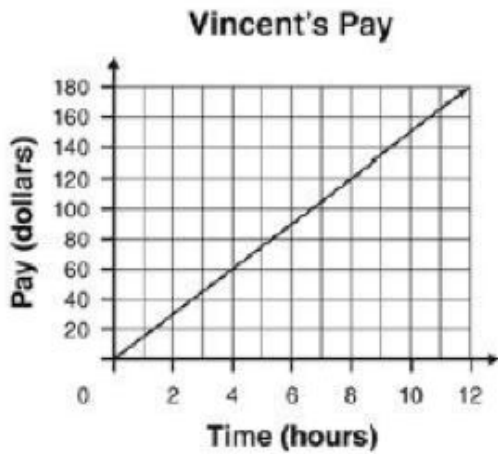
12. Mike earned the amounts listed in the table below while working as a welder in the fabrication unit. Write an equation to show how much money Mike earns, E, for any number of hours worked.

Hours Worked (h)	Amount Earned (E)
15	$183.75
22	$269.50
26	$318.50

Name: _____

Around the World Recording Sheet
"Proportional Relationships"

#1	#2
#3	#4
#5	#6
#7	#8
#9	#10
#11	#12

Proportional Relationships Exit Ticket!

Analyze the table provided and answer the following questions on the notecard provided.

    1. Does the table show a proportional relationship?

    2. What is the constant of proportionality?

    3. Does the table show direct variation? Write the equation for direct variation if possible.

x	y
3	12
5	20
7	28
9	36

Lesson #2

Proportional Relationships within Manufacturing

Description

Hyster-Yale Group produces on average about 160 lift trucks each day. It is crucial that employees on the line work at a consistent rate in order to ensure on-time delivery to the customer. Through this lesson students will explore unit rates and proportional relationships to see how they connect and are found in the real world.

Introduction

The following lesson will cover unit rate, direct variation, constant of proportionality, and analyzing charts and graphs. This lesson will be heavy on word problems involving real-world scenarios.

Curriculum Alignment

- 7.RP.1- Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
- 7.RP.2- Recognize proportional relationships between quantities.

Objectives

- Students will be able to recognize unit rates and rate of change associated with ratios of fractions. (7.RP.1)
- Students will be able to recognize and analyze proportional relationships between quantities. (7.RP.2)
- Students will be able to understand how proportional relationships can be found throughout the manufacturing process.

Time & Location

These few lessons will last about 2 days with class periods lasting 70 minutes each. The lessons will take place in a regular 7th grade math classroom.

Teacher Materials

- Interactive Notebook
- Document Camera/Projector
- Markers
- Giant Poster Paper
- Rubrics for Presentation

Student Materials

- Writing Utensils
- Interactive Math Notebook
- Calculator

- Rubric for Presentation
- Viewing guide "Proportional Relationships in Manufacturing"

Safety

There are no potential safety hazards for this particular lesson.

Student Prior Knowledge

This lesson is towards the beginning of the Ratios and Proportions unit and will come after students complete a foldable on basic rates, ratios, and proportions. Students should have a good understanding of what each is and how to recognize them in math problems/scenarios. Students should also be able to recognize that a unit rate is a rate in terms of 1. Students should also be able to recognize equivalent fractions and how they make up a proportion. It would also be beneficial if students are familiar with using and plotting points on a coordinate grid. This series of lessons will come next in the R.P. unit. Students should also know how to utilize the "CUBES" strategy for solving word problems in mathematics.

Teacher Preparations

- Have poster and markers ready for presentations
- hare the viewing guide on Proportion Relationships in Manufacturing through Google Classrooms, or have a few copies ready to hand out to each group.
- Teacher will need a timer displayed somewhere in the classroom.

Activities

1. Do Now (5-10 minutes)
   - Students will come in and complete the "Do Now" involving finding unit rate posted on the board. (5 minutes)
   - Instructor will go over the correct answer to the problem.
2. Direct Variation Viewing Guide and Poster (40-50 minutes)
   - Students will work with a partner to complete the real-world scenario problems on the viewing guide provided. Next, students will create a poster presentation illustrating a real-world manufacturing example of direct variation found in manufacturing.
   - Students should use a table, graph, and an equation to represent direct variation.
   - Students should also provide the constant of proportionality and direct variation equation.
3. Poster Presentations (10-15 minutes)
   - Students will be given 1-2 minutes to present their posters to the class.
   - All students must take part in the presentation.
   - A criteria for success will be used for grading the assessment.
   - Presentations may need to roll over into the next day.

Assessments

1. Poster Presentation
   - Students will work with a partner to create a poster example explaining direct variation using a real-life scenario. Students will present their findings to the class. Students should use visuals (pictures, charts, graphs, etc.)

Critical Vocabulary
- Ratio- a comparison of two or more numbers
- Rate- a ratio comparing two numbers with different units
- Unit Rate- a comparison of two measurements in which one term has a value of 1
- Proportion- an equation showing two ratios are equal
- Direct Variation- when two two variables are related in such a way that the ratio of their values always remains the same; $y=kx$
- Constant of Proportionality- the constant value of the ratio of two proportional quantities x and y; represented as k
- Proportional Relationship- a relationship between two variables in which one is a constant multiple of the other
- Complex Fraction- a fraction with fractions in the numerator and/or denominator

# Proportional Relationships in Manufacturing

In manufacturing, most plants use a practice known as Demand Flow Technology (DFT) when designing their assembly lines. DFT helps in many ways including eliminating wastes, increasing production time, decreasing customer turnaround time, ensuring quality products, and much more. In order to hold employees accountable, each stream on each assembly line contains a flow-rate board where employees record their production. This is one of the many aspects of DFT.

CLICK HERE to watch a video clip to see more inside a manufacturing plant, Hyster-Yale, located in Greenville, NC.

Below are many examples of how DFT could be used in a manufacturing plant to show proportional relationships. The data provided is from various streams of Assembly Line #2 at the HY plant. Determine if the data shows a proportional relationship. If so, give the constant of proportionality as well as the direct variation equation. Work with a partner to complete each example.
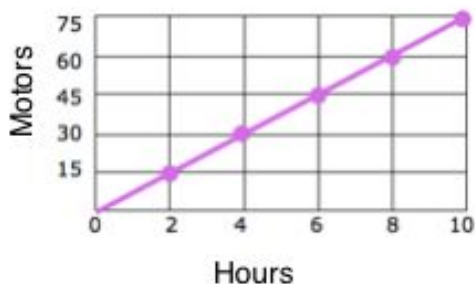
1)
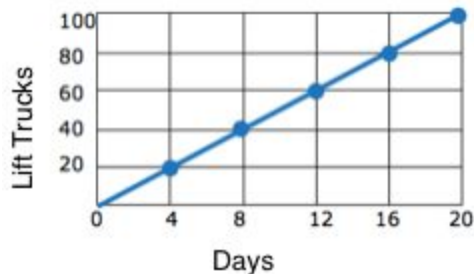
2)

Bolts Assembled (y)	39	48	60	93
Minutes (x)	13	16	20	23

3)

4)

Test Laps (y)	12.5	25	37.5	50	62.5
Miles (x)	0.5	1	1.5	2	2.5

5)
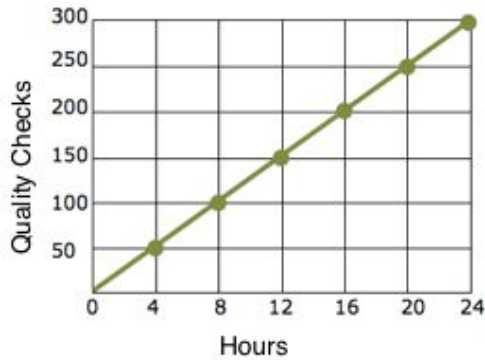
6) **Create your own example**! With your partner, create a poster presentation illustrating a real-world manufacturing example of direct variation. You poster should include the following:
- Table to display data (with appropriate labels)
- Graph with coordinates that correspond to the table (with appropriate labels)
- Constant of Proportionality
- Direct Variation equation for data
- Real-World example
- Math used when creating the example

You will be given 1-2 minutes to present your poster to the class.

Criteria for Success

Met/Not Met	To accomplish the Direct Variation mini challenge, the following tasks must be accomplished.
	Math Content: Student completed all aspects of the poster. Work was neat and clearly laid out.
	Math Content: Student made a table and graphed the coordinates correctly on the poster.
	Questions: Student correctly answers all problems and provides the direct variation equation and constant of proportionality for all.
	Directions: Student clearly followed all directions given.
	Collaboration: Student was always on task and did not have to be redirected.

Lesson #3
Demand Flow Technology
Analyzing Efficiency through Proportional Relationships

Description
A common practice in advanced manufacturing is Demand Flow Technology (DFT). The overall purpose of DFT is to complete tasks more efficiently, all while eliminating wastes.

Introduction
In this lesson students will learn about the importance of Demand Flow Technology. Students will have an understanding of why DFT is important in manufacturing plants as well as in their everyday lives. After learning about DFT students will participate in an assembly line activity where they track their progress throughout the session. Through this lesson students will revisit unit rate, constant of proportionality, and direct variation.

Curriculum Alignment
- 7.RP.1- Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
- 7.RP.2- Recognize proportional relationships between quantities.

Objectives
- Students will be able to recognize unit rates and rate of change associated with ratios of fractions. (7.RP.1)
- Students will be able to implement Demand Flow Technology in their everyday lives.

Time and Location
The following lesson can take place in any classroom. The lesson itself is based upon a 70 minute class period. The lesson is designed to be used in a 7th grade classroom, but can be implemented in any grade level with a few adjustments.

Teacher Materials
- Christiana's Waste Elimination video- https://www.youtube.com/watch?v=QA1ddcXfqM0
- Legos for mini house
- Flow Rate board to record unit rate of production
- Laptop and projection screen/Promethean board

Student Materials
- Interactive math notebook
- Writing utensil
- Legos
- Mini dry-erase boards

Safety

Student Prior Knowledge

Before beginning this lesson students should have a good understanding of proportional relationships (taught in lesson #1). Students need to know what unit rate is and how unit rate relates to direct variation.

Activities

1. Build a mini house (legos) (5 minutes)
   - Team members will be asked to build as many quality mini houses as they can with the legos provided in 2 minutes.
   - A photo of the desired outcome should be provided (teacher will determine what works best for the legos/building blocks available).
   - Allow team members to work together in small groups.
   - Materials should be unorganized and spread out. No instructions should be provided. Only the picture!
   - Instructor will keep up with the time using a stopwatch or timer.
   - After the first cycle, have students organize their stations to make better use of their time (try not to give hints). Complete the activity again and see if the time decreases. Complete the activity at least 3 times. Be sure to record all times on the board.
   - The purpose of this introductory activity is to show students that the 5s system is crucial to production in manufacturing. This will also allow students to see that when wastes are eliminated, production time will be quicker and more efficient.
2. Show Christiana's Waste Elimination video clip that illustrates the use of the 5s system. (7 minutes) https://www.youtube.com/watch?v=QA1ddcXfqM0
   - After watching the video clip, see if employees can use what they learned to complete the activity even quicker.
   - Help students organize their stations using the 5s system.
   - Through this video students will understand that utilizing the 5s system is not only beneficial in manufacturing, but also their everyday lives.
3. Class discussion on DFT and 5s system (10-15 minutes)
   - Instructor will lead a class discussion on what was seen in the video.
   - How did Christiana drop her unit rate of production time?
   - Does eliminating wastes truly decrease time of production?
   - How is DFT relevant to our everyday lives? Where else could we eliminate wastes in our daily routines?
4. Repeat the activity. (30-40 minutes)
   - Now that the students have an understanding of DFT, allow them to complete the process again (about 3-5 times). Through this activity, students will be asked to build the mini houses again using DFT and the 5s System to increase the unit rate of production. Students will record their totals on the flow rate board provided (mini dry-erase boards).
5. Exit Ticket (5-10 minutes)

- Students will be assessed on whether or not they can determine if a proportional relationship can be found with the data they collected through the DFT activity.

Assessments

Exit Ticket

Critical Vocabulary

- Ratio- a comparison of two or more numbers
- Rate- a ratio comparing two numbers with different units
- Unit Rate- a comparison of two measurements in which one term has a value of 1
- Proportion- an equation showing two ratios are equal
- Direct Variation- when two two variables are related in such a way that the ratio of their values always remains the same; y=kx
- Constant of Proportionality- the constant value of the ratio of two proportional quantities x and y; represented as k
- Proportional Relationship- a relationship between two variables in which one is a constant multiple of the other
- Complex Fraction- a fraction with fractions in the numerator and/or denominator
- DFT- Demand Flow Technology
- 7 Wastes- defects, over-production, transportation, waiting, inventory, motion processing
- 5s System- Sort, Set in Order, Shine, Standardize, Sustain

Direct Variation Unit Test!

- https://goo.gl/forms/1eZJyY8ZrVUDCMB03
- The following test will assess student knowledge of proportional relationships, constant of proportionality, and direct variation.
- Standards addressed: 7.RP.1, 7.RP.2