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Developing Mathematical Minds — Learning Fractions Through Career and Technical

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Introduction

My goal for this curriculum unit is to create lessons that are user friendly for the teacher and make the transition from whole number to parts of a whole number easy to comprehend for students. In doing so, the students will be able to master the concepts of fraction through highly engaged lessons with a relevant, real-life, career and technical approach.

During the first week of class, most students walk into my classroom taking deep breaths and with fearful looks on their faces. I assure them that we are going to have fun and math class will be a highly interactive class with lots of support. I give them a visual tour of the classroom, pointing out all resources available for the school term. They are still not impressed or encouraged about math class. The only equation they seem to remember is 'student plus math equals failure'. My goal is to create a user-friendly curriculum unit for students and teachers. Students should not to be afraid to learn math or associate math with a traumatic experience. I chose to write a curriculum unit on fractions because they play a major role in the learning of mathematics.

I teach mathematics in a Title 1 Priority inner-city middle school in Richmond, Virginia. The school district has approximately 23,000 students. The school where I teach has slightly over 400 students. The school's state accreditations status is accredited with warning. I instruct students with disabilities who are in the 6 th , 7 th and 8 th grades. All grade levels are taught independently of each other in 70-minute blocks. The disabilities in my classroom include: Specific Learning Disabilities, Emotional Disturbance, Autism, Other Health Impairment, Visual Impairment, Multiple Disabilities, Speech and Language Impairment. Approximately 30% of the students at the school are English Language Learners (ELL). In my classroom, I service one ELL student with a disability who has not attended school in a number of years, but was placed in middle school due to age appropriateness. Large portions of the students are highly transient which means attending multiple middle schools during 6 th – 8 th grades.

According to the Virginia Department of Education, the middle school where I teach categorizes 85% of the students as economically disadvantaged. Deficiencies continue to surface in the areas of mathematics and

reading. The school district has turned to outside educational agencies for academic supports with the goal of improving student outcomes in the areas of mathematics and reading. The educational agencies provide content instructional coaches who assist the teacher with instruction and delivery of content. The instructional coaches gather resources to support the learning in the school. At times, they offer strategies to assist with supporting a student's educational needs. I instruct students who are on average two to three years below grade level, which academically places them at the elementary level. In my classroom, parental engagement is strong: a little over 80%, but the majority of the parents can only provide behavior intervention support, not academic assistance.

A large number of my students have expressed interest in attending the local Richmond Career and Technical Center (RTC). The RTC provides training for students whose goal is to enter successfully into a specialized career and/or higher learning. However, the students are leaving middle school with minimal experience in the area of occupational math. The current instructional curriculum covers consumer math situations, but little occupational math. The students must be able to make connections between what they are learning in the classroom and occupational math.

My curriculum unit will emphasize basic conceptual understanding of fractions. The unit will allow the student to develop and identify the importance of solving real world mathematical problems, which pertain to possible career choices. The student will be able to understand and see how fractions play key roles in learning and choosing a vocation as a career option. The students will also be able to create and solve problems involving career and technical education.

This unit will emphasize an approach to fractions via unit fractions, which is consistent with what is advocated by the Virginia State Standards of Learning (SOL). In order to build towards conceptual understanding, the unit will take advantage of pictorial representations, which include linear models (fraction strips, rulers and the number line), area models (rectangles, squares and sometimes other shapes), set models (various items), and circle models.

Rationale

Teaching math today is very different from when I attended school from 1976 – 1988. The lecture teaching style was the constant instructional method used then. As a 20 th century learner, I remember being given an assortment of facts that were taught using the lecture approach. The teacher of today is expected to approach teaching using hands-on and active learning methods. Unfortunately, higher education does not fully prepare the teacher to tackle a 21 st century classroom. Teachers are entering the classrooms with little to no understanding of how to deal with multiple learners (general education, special education, english language learners) in a single classroom setting. Prospective teachers also have limited technology experience. Writing this curriculum unit is extremely important to me because the students need to clearly understand fractions and how they are prevalent in the career and technical education. In this ever-so-changing society, students must to be able to immediately comprehend how the learning outcomes are directly related to their occupations.

Teaching in my classroom requires me to use auditory, visual, and kinesthetic learning styles simultaneously. In my school, I am responsible for writing lesson plans for 6 th , 7 th and 8 th grades, which include multiple

teaching strategies. I incorporate the appropriate differentiations of instruction as determined by the ability level and learning styles of the students. The majority of the students can master topics as long as they are willing to give full attention during class and take advantage of extended learning opportunities which include before or after school tutoring.

The students in my class are very emotional and highly sensitive. Most of them are fully aware they are lacking skills to understand concepts being introduced to them in class. I have had students cry as I was explaining concepts, noting they have never understood or been "good" in math or they "just don't get it." This curriculum unit is designed to teach me, fellow educators, and students to embrace change as we begin to think differently about fractions. Together, we will explore and learn new methods to gain a deeper understand of fractions. This curriculum unit is intended to be fun! In the process, my students will quickly gain conceptual understanding of fractions using concrete manipulatives and word problems.

Background and Teaching Strategies

Basic Concept

The goal is to teach with the Virginia Standards of Learning (SOL) as the guide. The SOL and curriculum framework surrounding factions presume that the student has number literacy for ones current grade level. The lesson will ask require the student to be able to read and write using the number language. I want to teach the students to develop an understanding of fractions as numbers. Using the number line to teach this objective will allow the student to have a visual of the position of number. The number line will also allow my students to see that every fraction can be represented as a point on the line. My students will learn how to build fractions from fraction units, recognize and generate simple equivalent fractions such as 1/2 = 2/4 or 3/3 = 1. I will also use a circle model when teaching this concept. The circle models allows for kinesthetic and visual learning to take place. Circle models are easy to move around. The teacher or student can label and partition according to the directions given by the teacher. Teaching the student how to decompose fractions into smaller fractions usually causes little to no stress to the student. I can use area, linear or circle models to teach this concept.

The majority of the issues in my class begin when the lesson involves the five critical components of reading: phonemic awareness, phonics, vocabulary, fluency, and reading comprehension. The students are faced with reading word problems, which contain grade appropriate vocabulary. According to R. Howe, building vocabulary is essential in teaching mathematics. [3] Solving word problems becomes very challenging and upsetting to the students because they lack many of the critical components of reading. Anytime I am teaching word problems, I must use as many different models as possible. I will also have a listening station where the student can "plug and learn". The "plug and learn" listening station acts as a guided learning center. I will record the SOL number, learning objective and pages to the lessons in the textbook, reference key vocabulary words, and read actual or modified steps to solving a word problem. I will record problems for the students to solve in the textbook and on a worksheet. Most of my students have the read aloud accommodation listed on their individual education plans. The "plug and learn" listening station allows for private teaching reinforcement of lessons and accommodates the auditory, visual and kinesthetic learner as the lesson guides the student to use various manipulatives which are near the listening station labeled by SOL number.

The students will learn how to compare and add fractions with the same denominators. Using area, set or circle models can easily teach these objectives. Comparing fraction with like denominators only poses a problem when I change the language from bigger and smaller to greater than and less than. The student has to then remember the meaning and direction of the > or < signs. As the same fractions are being changed, students often are able to tell me which fraction is bigger or smaller, but are not able to give the correct information in the number sentence. Once we begin the comparing lesson, I make the greater than and less than sign as a part of the entry or exit ticket and posted in the room. I tell the student to write a/b + c/b = a+c/b when adding fractions. The students are reminded that in order to use this formula, the denominators must be the same, and then just add the numerators together. Some students will want to add the denominators but I will refer them back to the models asking them recall the denominators of the model sets we are using, to help them see that the denominator should not change.

Objectives

Unit

A unit is a designated quantity that we use to measure other quantities of the same kind. We meet many, many units in everyday life. For example, we use inches or feet or miles or centimeters or meters, etc., to measure length. We use quarts or pints or (fluid) ounces or liters, etc., to measure liquids. We use pounds or (dry) ounces or tons or grams or kilograms, etc., to measure weight. The above examples are used in a wide variety of situations, but in particular situations, we may use a more specialized amount as a unit. For example, a storeowner might think of a box of 15 chocolates as a unit, for measuring her supply of chocolate, or someone who is writing a lot of letters may think of a sheet of 20 stamps as a unit for measuring his stamp supply. In order for the student to become familiar with units, the student must get used to writing the units in answers. I plan to raise my students' consciousness for units. For example, I can ask the class "How much soda is in my bottle?" They might answer 10. Then I would ask, "10 what? 10 cm, 10 oz, 10 cups?" Just revealing the number 10 does not give a clear answer to the question of how much soda is in the bottle. Giving the unit with the unit allows the response to be clear and allows for a good mental picture. Providing only a number will not answer the question. The unit gives the number meaning.

Unit Fraction

A unit fraction is a fraction whose numerator is one and whose denominator is a positive integer, d. Later my students will learn to think of this as the reciprocal of a positive integer, 1/d. A unit fraction 1/d of some quantity is something that d of it makes the quantity. Many unit fractions are already incorporated into our standard systems of measurement. For example, since 2 pints make a quart, a pint is ½ of a quart. And since 2 cups make a pint, a cup is ½ of a pint. And since 4 quarts make a gallon, a quart is ¼ of a gallon. In linear measurement, an inch is 1/12 of a foot, a foot is 1/3 of a yard, and a yard is 1/1760 of a mile; a centimeter is 1/100 of a meter, and a meter is 1/1,000 of a kilometer. There are many other such examples, and I will spend time with my classes discussing and listing examples.

General fraction

A general fraction is made by taking several copies of a unit fraction. It is represented symbolically as: n/d = n x (1/d) = n copies of 1/d. The numerator n of a general fraction tells us how many copies of there are of 1/d.

For example: 3/5 tells us 3 x (1/5) = 3 copies of 1/5. I believe that breaking the idea of fraction into parts, the unit fraction and multiples of a unit fraction, will assist my students in gaining conceptual understanding of the true meaning of the fraction. They will be able to make connection with unit fractions when learning general fractions. We will discuss many, many examples, such as 3 inches is 3/12 of a foot, and 10 minutes is 10/60 of an hour, 8 ounces of milk is 8/32 of a quart, etc., etc. In some of these examples, some students may notice that the fraction can also be described in other ways: since a foot is made of 4 segments of 3 inches each, 3 inches is also ¼ of a foot; since 6 intervals of 10 minutes make an hour, 10 minutes is also 1/6 of an hour; since 8 ounces is makes a cup, and there are 4 cups in a quart, 8 ounces is also ¼ of a quart. In such cases, we will recognize that the same quantity can be expressed by different fractions, or that we can name a quantity as a fraction in many ways. Although I want my students to recognize simple examples of renaming, this unit will not include a systematic study of renaming fractions.

Visual Prototypes of Fractions

Students require multiple interactions with fractions. Students must be able to conceptually understand that fractions express quantities that are not whole multiples of a unit, especially parts of a unit. Pictorial representation gives the students a visual tool in which to draw meaning. In class, the students must be given several visual models of fraction in order to make relationships. If given several representations of the same fraction, this will increase the student's ability to understand and make connections. In working with all these visual representations, I will make sure that my students can identify the unit, and the part that represents a unit fraction, as well as the particular fraction represented.

Variations of Models

Area Model

Singapore Math recommends using squares and rectangles for area models, since these make it easier for the student to grasp the visual representation. [5] Other examples of area models include: geoboards, circular fraction regions and folded fraction pieces. The area models in Figure 1 and Figure 2 both illustrate 5/9. The large rectangle is the whole or unit, and since there are 9 equal small rectangles in the large one, each is 1/9 of the whole. Five of the 1/9s, or 5/9s, have been shaded.

Figure 1.

Figure 2.

Linear Model

According to R. Howe, a linear model of a fraction n/d can be simply a line segment representing the whole,

partitioned into d equal pieces, with n of the pieces distinguished in some way. [2]

A more sophisticated linear model for fractions is the number line. According to Howe, most students will see a visual model of linear measurement during early primary grades in school. [4] The number line is an idealized ruler. It has a distinguished point, the origin, and a distinguished segment, the unit interval, which establishes the unit of length. The origin is at one end, normally the left end, of the unit interval. A point on the number line is then labeled by a number that tells how far the point is from the origin, as a multiple of the unit length. So, the origin is labeled by 0, since it is zero distance from itself, and the other end of the unit interval is labeled with 1. The point that is twice as far from the origin as 1 is labeled 2, the point that is 3 times as far is labeled 3, and so on. Figure 3a shows a number line with the first few points labeled by whole numbers.

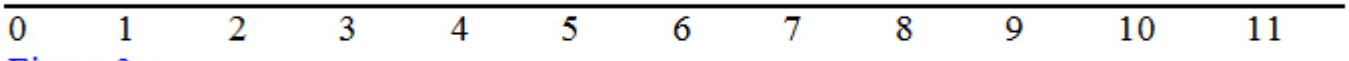


Figure 3a

Fractions can be placed on the number line using the same ideas. The point that is half as far from the origin as 1 is labeled ½. The interval from 0 to ½ is half as long as the unit interval, and the interval from ½ to 1 is the same length; it takes 2 intervals of length ½ to make the unit interval. Since 1 is also at distance 2x(1/2) = 2/2 from the origin, we see that 2/2 = 1, which is an example of renaming. We can continue to label points that are multiples of ½ from the origin. The middle of the interval between 1 and 2 is 3x(1/2) from the origin, so it is labeled by 3/2. Another interval of length ½ gets us to 2, which is therefore also equal to 4/2. Figure 3b shows a number line with the first several multiples of ½ labeled, and Figure 3c shows a number line with multiples of 1/3 labeled.

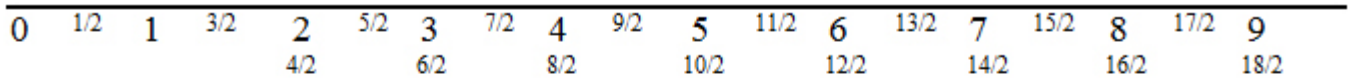


Figure 3b

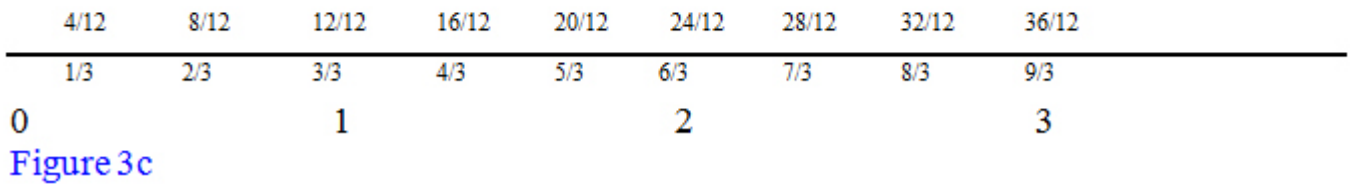


Figure 3c

In my classroom, I have examples and concrete samples of number lines. Number lines are displayed on the window blinds and on the tile floor. I have a mobile number line displayed in the front of the classroom, which displays negative and positive numbers. Other examples of linear models include rulers, cuisenaire rods, and fraction bars.

Set models

A set model is an assortment of items such as 3 yellow, 5 blue and 4 red airplanes. In my classroom, I have set models in clearly marked Ziploc bags with directions in each bag on a laminated index card. This allows clear directives, easy access to the item and keep item neat and orderly. The collection below is an example of a set model.

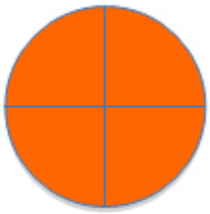
Figure 4

In the above set model, all the pieces are to be considered equivalent; 3/9 or 1/3 are hearts, 2/9 are circles and 4/9 are squares.

Circle Models

I really enjoy working with circle models. Student find circle model easy to manipulate. They employ a level analytical thinking with a concrete manipulative. Each student is give a full set of circle model with all pieces, in the same color grouping, equivalent to a whole. The circle model below details a whole circle partitioned into 4ths. In my class, I allow the student to partition the items. Students must be able to divide items in parts, as this will build conceptual understanding of fraction. The tortilla is perfect for partitioning. I will give a directive on partitioning and the student will divide the tortilla accordingly.

Figure 5



Tools

I always allow the students the freedom move throughout the classroom, if the movement will impact their learning in a positive manner. The students who require learning tools are free to move quietly to get to tools without disrupting the instruction. I try to remind students at the beginning of class of which learning tool could be helpful for learning the content of the day, but ultimately it is the decision of the student. At times, I do require student to use a specific tool.

According to Lamon [4] , blending relevant tools with appropriate teaching is imperative for conceptual knowledge to take place. [1] The teacher should plan the lesson and activities around simple tools before moving to complex learning tools. I always give my students time to explore any new learning tools, which will be introduced and used with the lesson I am teaching. In doing so, the student can remain focused on the lesson being taught and not fumble with the new manipulative during instruction.

Folding of Paper

According to Singapore Math, students can learn fractions with ease if folding paper is used as a model. [6] I have the students to fold paper in order to represent common fractions, describe equivalent fractions, to add fractions and to characterize equivalent fractions and to compare various fraction sizes. As part of this activity, I want students to understand that the unit fraction 1/d gets smaller as d gets larger.

Number line

A number line can best be described as a continuous ray that represents numbers. Since the number line is a visual image, the student can begin to do mental math. Visual images are important because the students can see where numbers belong on the number line. I allow the students to draw number lines or to solve problem on the desk with a dry erase pen.

Clothing

I have always used "fashion design" as a means to teach fractions and measurement. The students have such a great time creating the shirts; they often forget we are actually learning simple and complex fractions. The students enjoy creating fringes on the shirts. They are free to measure the length and width of the fringes they will be creating fractions. For the initial fashion design, all the fringes will be equal in length and width. The students will be allowed to be creative with individual fringes. We have a showcase where the students will talk about their shirts and about all the fractions represented on the shirt.

Tortillas

According to Martinez and Martinez, the tortillas will serve as a motivation and a manipulative. [5] The student will use the tortillas to create unit fractions such as 1/2, 1/3 and 1/4. The tortilla is great comparing fractions and equal sharing. If working in pairs, students will be able to increase social skills while learning about fractions.

Career and Technical Education

Career and Technical Education is very popular in the City of Richmond School District. The City of Richmond is home to the Richmond Technical Center (RTC), which serves four neighboring counties. I will illustrate fractions using occupational math as it relates to career and technical education. The RTC offers course study in automotive, business, collision, electrical, food service, HVAC, home improvement, medical, manufacturing, personal service, security, technology information, tradesman, continuing education and welding.

Spelling/Math Vocabulary Fractions

In my class, using words helps the students to understand fractions. The student will break the words out in vowels and consonants. For example: the word *math* has 1 vowel (a) = (1/4 of whole word is a vowel) and 3 consonants (m,t,h) = (3/4 of whole word are consonants)

Word	What fraction of Vowels?	What fraction of Consonants?	
Math	1/4	3/4	1 Whole Word
Decimals	3/8	5/8	1 Whole Word

Candy (M & M or Skittles)

Both of these candies provide great examples for set models. There are various models of the same items. The students can quickly disaggregate the data sets into ratios, which are other forms of fractions. After instruction, the student should be able to compare sets to sets and a set to the whole.

Strategies

Daily Routine

My class always begins with a snapshot as required by the school district. A snapshot is an activity that requires approximately five minutes for the student to complete. The snapshot must consist of only review material. Since, I teach 6 th , 7 th and 8 th grades, the snapshot is usually placed on the whiteboard before I leave school. Typically, I will have a minimum of three math problems on the board. One math problem will always consist of something relating to fractions for all grade levels. Our school has the acronym DASH in place, which means D – Date, A –Assignment, S – SOL and H – Homework. I fill in all slots for the next day before leaving each afternoon.

Collaborative Seating Arrangements

Seating in my classroom varies according to the grade level and behavior. My goal is to make the students as comfortable as possible. My classroom is 1/3 of the average size classroom, not a lot of room for varied seating arrangements. With approximately 15 students in the classroom, they can become easily irritated with each other. I currently have my students sitting in groups of two. I have students who request to sit in an individual seat, move to a group for activities, returning to their original seat after the activity. A collaborative seating arrangement allows the student to have someone who can act as immediate support if a problem arises when solving problems.

Composition Notebook

Every student in my class has a math interactive composition notebook. This notebook is for daily usage. The student will keep notes according to the SOL we are learning or reviewing. The math interactive notebook goes home as often as the student desires, but must return daily to math class. All students are required to take the notebook home to review for the 9 –week Pre SOL assessments. There is a parent log located in each composition book for students who require closer monitoring by the parent and teacher. The parent and teacher can write comments in the composition book.

Instruction in my classroom varies according to the degree of difficulty of the SOL. Before, I introduce a new SOL, all my assistant teachers are required to pre-assess their students. All students are apart of whole group

instruction. Typically, after whole group instruction and guided practice, students will be placed in rotating stations. I usually have heterogeneous groupings, since the majority of my student's ability levels vary slightly. I will have four to five rotating stations (depending on the time) with various activities. One station activity will always be of the lesson taught for the day. One station of today's instruction and the rest will be activities according to needs, which is revealed by the data. Every student is assigned to a station. I will then call individual students to the teacher station for remediation, pulling one student from each group to form a small group. Doing this preserves each student's dignity, since they are not always being in the low group and spending the majority of time at the teacher station. At times, I offer selected students individual teacher station time. The students are required to sign-up for an individual session, at the beginning of class or after whole group instruction.

Activities

In order to capture the career and technical components, it is a good idea to align the lessons with real life courses offered at your local career and technical center. This will provide opportunities for students to make relationships between fractions and their real life usage. For the lessons listed below, the days are subjected to changes in order to fit the needs of the students.

Lessons

Day 1 – Discuss Units
Day 2 – Review Units
Day 3 – Quiz on Units
Day 4 – Discuss Unit Fractions
Day 5 – Games - Review Units and Unit Fractions
Day 6 – Quiz on Units and Unit Fractions
Day 7 – Discuss General Fraction
Day 8 – Review General Factions, Unit Fraction and Units
Day 9 – Games - Review General Fractions, Unit Fractions and Units
Day 10 – Assessment on General Fractions, Unit Fractions and Units
Day 11 – Make Fractions by Folding Paper
Day 12 – Placing Fractions on a Number Line
Day 13 – Discuss Decomposing Fractions into sum of Fractions
Day 14 – Games - Review All lesson previously taught
Day 15– Quiz Combining Various Lessons
Day 16 – Adding fractions with same denominators
Day 17 – Comparing fractions with same denominators
Day 18 – Solving word problems involving adding fractions with like denominators
Day 19 – Games – Review all or parts of previous lessons taught
Day 20 – Assessment Various Lessons
Day 21 – Introduce multiplication of fractions by whole numbers
Day 22 – Review multiplication of fraction lesson
Day 23 – Word problems involving multiplication of fractions with whole numbers
Day 23 – Assessment of Multiplication of fractions by whole numbers

Day 24 – Review Various Lessons
Day 25 – Review Various Lessons
Day 26 – Games – Review multiple lesson with games
Day 27 – Games – Review multiple lessons with games
Day 28 – Assessment of various lessons
Day 29 – Assessment of various lessons
Day 30 – Assessment of various lessons

Lesson # 1

Objective: Student will develop understanding of fractions as numbers

Time: 35 minutes of a 70-minute block or as teacher deems appropriate

Materials: Smart board or whiteboard (chalkboard), paper, scissors, pencil, ruler, colored pencil

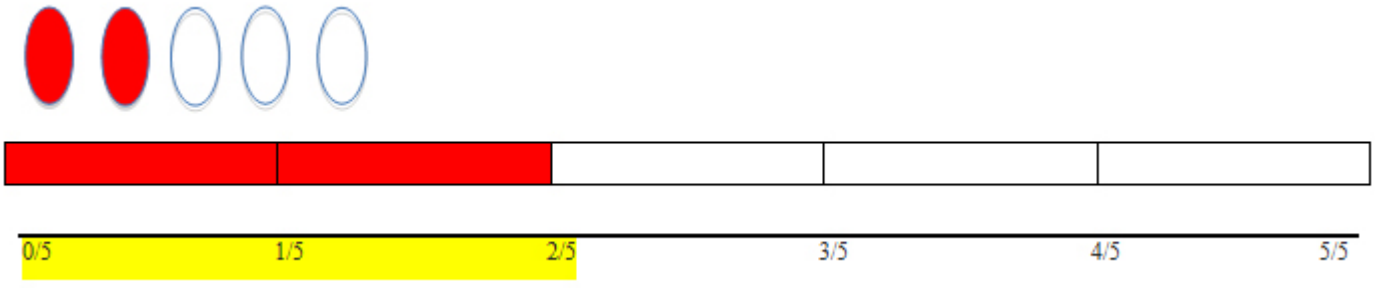
Fraction vocabulary: unit, fraction, numerator, denominator, number line, equivalent fraction, whole, part.

Opening: Using the smart, white or chalkboard draw a line broken with 6 vertical lines going sections. Ask the students the how long the line is. The students will give the teacher various numbers without a unit. Allow the student to either working groups to discuss their answers or have an open class discussion on why the answers where selected. Go to background and teaching strategies section and discuss *unit*. This will get the students to understand the important of naming the unit in union with the number.

Career and Technical Relationships: Discuss the importance of naming the unit if working in hospital (health care), food service (restaurant) or automotive (repair or paint shop) industries.

Give the paper allow the student to work in pairs. Directions: Write the fraction 2/5 on the board. Tell the students who are in pairs they must tell what the fraction means and what it looks like using one picture drawn, one picture made using paper, sciss and on a number line. Example: The 5 represents how many total parts are in the whole, the 2 represents the number of copies of *d,* 2 x (1/5). Write 6 more factions on the board and have the students repeat the directions. Monitor the student and select student to share out in class the various models.

Below is a sample of various 2/5 models according to the above directions: This is what 2/5 looks like…



Appendices

Appendix A: Worksheet

Name _____ Date _____

What Does this Fraction Look Like?

Directions: Review each fraction. Using a pictorial representation, draw one and create one model of the fraction listed below. Create a number line, which models the fractions. Refer to class notes if you need assistance.

1. 4/5

   Draw

   Create

   Number Line _____

2. 2/7

   Draw

   Create

   Number Line _____

3. 6/9

   Draw

   Create

   Number Line _____

4. 2/3

   Draw

   Create

   Number Line _____

5. 7/8

   Draw

   Create

   Number Line _____

Name_____ Date_____

Career and Technical Mathematics: Adding fractions

Directions: Evaluate and solve the following word problems.

1. In horticulture class, Briana watered 2/7 of the plants on Monday and 4/7 of the plants on Tuesday. Did Briana water all of the plants? Prove your answer (picture or solving)
2. Ms. Jackson uses a 3/6 pint of milk, 1/6 pint of water to make a cake and 2/6 ounces of sugar. How much of liquid ingredients did Ms. Jackson use to make the cake?
3. Briana is painting her bathroom. She needs one-gallon of paint. She has one can with 4/7 of a gallon, and another can with 3/7 of a gallon. Find the value of four-sevenths gallons of paint and three-sevenths gallons of paint. Does Briana have a whole gallon of paint? Prove your answer (picture or solving).

Directions: Evaluate and solve the following factions. Write **greater than** by the fractions that are greater than one whole.

1. 9/16 + 9/16 =
2. 4/5 + 2/5 =
3. 9/13 + 4/13 =
4. 25/30 + 7/30 =

5. 40/100 + 60/100 =
6. 2/8 + 4/8 =
7. 42/58 + 15/58 =

Appendix B: Resources

- Khan Academy
- Buzz Math
- SoftSchools

Appendix C: Implementing District Standards

Virginia requires the teacher to use the Standards of Learning (SOL) for teaching mastery of concepts. The SOL learning objectives that I will address are in reference to fractions. Standard Virginia Standards of Learning which will be included in this unit are as followed:

6.2 The student will

a) investigate and describe fractions, decimals and percents as ratios;
b) identify a given fraction, decimal or percent from a representation;
c) demonstrate equivalent relationships among fractions, decimals, and percents and
d) compare and order fractions, decimals, and percents
7. 1c The student will compare and order fractions.
8.1 b The student will compare and order fractions.

Notes

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1. Susan J. Lamon. *Teaching fractions and ratios for understanding essential content knowledge and instructional strategies for teachers*. (Mahwah: Erlbaum, 1999), 19

2. Howe, Roger. "Three Pillars of First Grade Mathematics and Beyond." Lecture, Yale National Teacher Initiative from Yale University, New Haven July 2014

3. Howe, Roger. "From Arithmetic to Algerbra." Lecture. Yale National Teacher Initiative from Yale University, New Haven, July 2014

4. Howe, Roger. "Number Line Basics." Lecture. Yale National Teacher Initiative from Yale University, New Haven, July 2014

5. Joseph Martinez and Nancy Martinez. *Activities for Mathematical Thinking: Exploring, Inventing, and Discovering Mathematics.* (Upper Saddle River, Prentice Hall, 2006), 184

6. Singapore: Schaffer Publishing, 2009

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Howe, Roger. "Three Pillars of First Grade Mathematics and Beyond." Lecture, Yale National Teacher Initiative from Yale University, New Haven July 2014. This lecture with documents provides foundation information surrounding various number operations.

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