Cooking with Numbers

Student/Class Goal
Students want to be able to take recipes and scale them as well as convert them into the US measurement system.

Outcome (*lesson objective*)
Students will recall prior knowledge of working with fractions and will apply measurement scales. Students will be able to solve problems using the appropriate conversion amounts.

Time Frame

2 hours

Standard *Use Math to Solve Problems and Communicate*
(Primary benchmarks in bold.)

NRS EFL
Levels 5-6

Number Sense	Benchmarks	Geometry & Measurement	Benchmarks	Processes	Benchmarks
Words to numbers connection	4.1	Geometric figures		Word problems	5.25
Calculation	**5.1/5.4**	Coordinate system		Problem solving strategies	5.26
Order of operations		Perimeter/area/volume formulas		Solutions analysis	5.27
Compare/order numbers	5.3	Graphing two-dimensional figures		Calculator	5.28(optional)
Estimation		Measurement relationships	**6.12**	Math terminology/symbols	6.30
Exponents/radical expressions		Pythagorean theorem		Logical progression	5.30
Algebra & Patterns	**Benchmarks**	Measurement applications	**6.13**	Contextual situations	**5.31**
Patterns/sequences		Measurement conversions	**6.13**	Mathematical material	
Equations/expressions		Rounding		Logical terms	5.33
Linear/nonlinear representations	5.17	**Data Analysis & Probability**	**Benchmarks**	Accuracy/precision	
Graphing	5.18	Data interpretation		Real-life applications	**6.36**
Linear equations		Data displays construction		Independence/range/fluency	5.36
Quadratic equations		Central tendency			
		Probabilities			
		Contextual probability			

Materials
Problem Solving Steps—Handout
Conversion Factors—Handout
Measuring Tools: Cup/Pint/Quart/Gallon…beans/rice/water/plastic fill for containers
Recipes: Can be the ones given on the handout or, for additional student integration, have them bring their favorites to class as well

Learner Prior Knowledge
Students should be familiar with applying all four arithmetic operations on fractions.
Reducing fractions.
Basic understanding of what a proportion is and how to solve one.
Students should be able to distinguish between metric and U.S. measurement terms as well as tell whether a term is for distance, volume, or weight.
Plotting points and knowing what a linear equation looks like.

Instructional Activities
Step 1: If necessary, a short review on fraction arithmetic, what a proportion is, measurement terms, and linear equations.

Step 2: Give them the handout on Polya's 4 step problem solving process.
We want our students to be able to follow a sequence of steps when solving problems. Whether they know it or not, they probably already sort of do this. We want them to follow Polya's four step process:

1. Understand the problem (*What is the unknown? The data? The conditions?*)
2. Pick a strategy to solve the problem (*Have you seen a similar problem? One with a similar unknown?*)
3. Implement that strategy to come to a solution
4. Review the work and the solution to make sure the solution makes sense in the given context.

After step 4, if there seems to be an error with the solution, students should go back to step 1 and repeat the process until they come to a solution that makes sense.

For the first few lessons, these steps should be discussed and written down so that students can refer to them as a guide when solving problems. During the *I do* steps, your thinking aloud should show you going through all four steps in the process.

Step 3 : Conversion background

Discuss with students instances when converting between units would be necessary. Examples include going from metric to the U.S. system, but also within each system: feet to inches, minutes to hours, ounces to cups, grams to kilograms, centimeters to meters….These conversions would be necessary if you are adding together the lengths of multiple small items. Each item may be measured in centimeters, but if you have thousands of them, the overall length may be given in meters or even kilometers. Or you may be adding together lengths or volumes in different units and you need them to be the same unit in order to add them. In a recipe, for example, if you have measuring cups that are strictly "cups," you will need to convert anything in the recipe that calls for quarts or gallons.

Step 4 : Metric Conversions

- (*I do*) Give them the Conversion Factors handout. Conversions in the metric system are the easiest to begin with as all conversions will include multiplying or dividing by a power of ten. Start by writing down some common metric prefixes: Milli-, Centi-, Deci-, and Kilo-. Students may be familiar with centimeters, decimeters, and kilograms, so the prefixes might not be entirely new. Since we'll be working with volume later, write down the metric unit for volume: liter. Now fill in some metric conversions: 1 liter = 1000 milliliters, 1 liter = 100 centiliters, 1 liter = 10 deciliters, and 1000 liters = 1 kiloliter. It may be a good idea to let them know this works for meters and grams as well, as milliliter is probably the only common term there.
    1. For the first conversion, you will do it, making sure to think aloud as you go so the students can follow your thought process when solving the problem. Tell them you want to know how many milliliters are in a kiloliter. First, set this up as an equation: 1 kiloliter = x milliliters. As part of the understanding the problem step, you know you need to find a conversion factor to go from kiloliters to milliliters. This means your number should be larger than one as you'll be using a smaller unit of measurement to measure the same amount. Make sure you stress that keeping the units is extremely important (they can treat them as if they are variables).
    2. Next, look at the conversion factors. We don't have one that will immediately take us from milliliters to kiloliters, so we'll have to go in steps. We do know that 1 kiloliter = 1000 liters. We also know that we can multiply anything by 1, or a fraction equal to 1, and not really change the value in our equation. Our strategy here, then, is to multiply by fraction(s) equal to one until we get to the appropriate units.
    3. Manipulate the conversion factor equation so that we have: 1 = (1000 liters)/(1 kiloliter), making sure to explain that you wanted the *desired* units in the numerator. Carry out the next step by multiplying by this fraction in the equation we are trying to solve. (Make sure to explain about cancelling out units!) We now have a new equation: 1000 liters = x milliliters. Next, we use the conversion factor 1 liter = 1000 milliliters. Once again, think aloud as you go through the same steps again. Find a fraction equal to 1: 1000 milliliters/1 liter. Multiply by that and cancel out units to get 1,000,000 milliliters = x milliliters.
    4. Thus, 1,000,000 milliliters = 1 kiloliter. We have the correct units and we did get a number larger than 1, so our review of the solution seems to be okay. Show them that this could have been done in one step by multiplying by two fractions: 1 kiloliter *
- (*We do*) Next, for the entire class, pose the problem of wanting to know how many liters are in 175 centiliters. This time, instead of just thinking aloud, you will want the class to give as much input as possible and only interject to help them reach a solution.
    1. We want to go from centiliters to liters, which is a larger unit of measure, so our number should decrease. If we set up an equation, we get 175 centiliters = x liters this time.
    2. Again, we want to multiply by fractions equal to one. I have a conversion factor involving centiliter and liters: 1 liter = 100 centiliters. Since my desired units are liters, I will manipulate this to become: 1 = 1 liter/ 100 centiliters.
    3. Now I take my fraction that is equivalent to 1 and multiply it by 175 centiliters to get that 175 centiliters is the same as 1.75 liters.
    4. Since our number decreased as we expected from step 1, our solution makes sense.
- (*You do*) This time, the students will work alone and you will provide guidance only if necessary as you check in with each student. Pose the problem that we want to know how many milliliters are in a half of a kiloliter.

Step 5: Finding U.S. Customary Unit Conversion Factors

Using the measuring tools, the class will find out the conversion rates among cups, pints, quarts, and gallons. Start with the two smallest: cups and quarts. It should be visually clear that the quart is bigger. Fill the cup container with the dry fill and then dump it into the pint. Keep track of how many times the cup container must be filled and dumped into the pint container before the pint container is full. Write the equivalence relation down: ___ cups = 1 pint. If there are enough materials, hand them out for students to find the rest of the equivalence relations. Otherwise, have a few come up to demonstrate finding some for the rest of the class. At the end, there should be the following relations:

2 cups = 1 pint

4 cups = 1 quart
2 pints = 1 quart
16 cups = 1 gallon
8 pints = 1 gallon
4 quarts = 1 gallon
(Also, if we know 1 cup = 8 ounces, students should be able to find the ounces in a pint/quart/gallon.)

Step 6: Using U.S. Conversion Factors

- (*I do*) Now we're going to incorporate the recipes. This can be edited to include ones the students brought in. However, there needs to be instances of different measurement units as in the examples on the handout. Start with the recipe for the vanilla milkshake. Milk and ice cream often come packaged as quarts and pints respectively. Tell the class that all you have to work with are a set of measuring spoons containing teaspoon divisions and a tablespoon, and a measuring cup that gives divisions for fractions of a cup up to two cups. You need to rewrite the recipe so that everything that needs to be measured is in teaspoons, tablespoons, and cups.
    1. Understanding the problem then, we know that we must take the milk and ice cream measurements and convert them to cups. As cups are smaller than quarts or pints, we will get larger values than the fractions in the recipe.
    2. Our strategy is to take the conversion factors we found before, manipulate them into the appropriate fractions equivalent to 1, and multiply. Let's do the milk first. We need to convert quarts to cups, so we take the appropriate conversion factor and manipulate it to be: 4 cups/1 quart = 1. We put cups on top because that is my *desired* units for my solution. For the ice cream, I'll use: 2 cups/1 pint = 1.
    3. Implementing the strategy means I multiply my fraction by the value in the recipe. So I take 4 cups/1 quart * (1/2) quart. This gives me 2 cups. I need to do it again for the ice cream: 2 cups/1 pint * (1/2) pint. This gives me 1 cup of ice cream.
    4. We knew our amounts should increase with the smaller measurement unit, so our answers do make sense.
- (*We do*) For the class-participation problem, use the cookie recipe. Again, convert to cups.
    1. This time, we must convert all the measurements in ounces to cups. Since a cup is a bigger measurement unit than an ounce, our numbers should decrease as we go from ounces to cups. We should also note that we have multiple instances of 4 ounces. We need only do the calculation once.
    2. We have three calculations to do then: 10 ounces, 4 ounces, and 6 ounces. (This may or may not be a good time to mention that ounces are also a weight measurement. We are assuming all ounces in the recipe are for volume, though.) We will take the conversion factor 8 ounces = 1 cup and manipulate it to become 1 cup/8 ounces = 1 as our desired units are cups.
    3. We multiply this new fraction by our three measurements to get: 10 ounces = 1 1/4 cups, 4 ounces = 1/2 cup, and 6 ounces = 3/4 cup.
    4. As all numbers are smaller than their equivalent ounce measurements, our solutions make sense.
- (*You do*) Give the students either the punch recipe, or their own, and have them convert everything to cups, teaspoons, and tablespoons.

Assessment/Evidence (*based on outcome)*

Each of the *you do* steps will serve as assessment. The instructor should be able to gauge understanding by having different students provide their solutions and explanations of how they arrived at that solution. In addition, during the *we do* steps, instructors should be encouraging all students to participate in the discussion. The ability to provide input in these discussions will help the teacher gauge each student's mastery of the concepts.

Have the students take the soup recipe and convert everything except the celery, carrots, and garlic to their equivalent cups measurement. With the provided Conversion Factors handout, they will be able to do even the teaspoon and tablespoon measurements.

Teacher Reflection/Lesson Evaluation

Not yet completed.

Next Steps

Use the handout on measurement conversions to graph linear equations/functions. For example: f(x) = 16x where x=number of cups and f(x) would then be number of gallons. Then use the graphs to determine the conversions for recipes.

Technology Integration

http://www.convert-me.com

Converter for multiple measurements
http://www.geogebra.org/webstart/geogebra.html
Online graphing tool
http://www.food.com/library/calc.zsp
Recipe conversion tool

Purposeful/Transparent
Students want to be able to use fractions in everyday problems. The teacher will model a practical use of fractions and conversions by modeling and guiding students through converting fractional ingredient amounts in common recipes.

Contextual
Measurement conversions come up in three main areas: weights, volumes, and distances. While this lesson focuses mainly on volumes, and possibly weights depending on the recipes used, the content knowledge extends to all three areas. Conversions are necessary in many job fields: health-related jobs, engineering jobs (construction, electricians, and carpentry), food industry, travel agents, and the airplane industry. In addition, using linear functions to chart a constant trend are used in many business settings and presentations.

Building Expertise
Students are already familiar with working with fractions. They are now using this knowledge in a real-life application as opposed to just applying the operations to numbers for a math class.