Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2009 Volume III: Science and Engineering in the Kitchen

Cook Me Up Some Equations

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Section One: Introduction

This past year, it was obvious that the kids were having difficulty making a connection between mathematics and the real world. With twelve years of teaching experience, my perception is that the problem is getting progressively worse. I am trying to use my past experience as a middle school science teacher to help solidify mathematics topics with science support. Early in the school year, the students responded to a survey of their interests and many referred to eating and cooking. In light of this initial quantitative research I concluded that a unit about cooking and recipes would be an excellent way for students to make connections.

The question I keep hearing is, "Why do I need math?" This unit will focus on answering that question while teaching life skills along the way. The unit will focus on the teaching of mathematical concepts while using recipes and cooking. Students will connect science and math across the curriculum. Hopefully they will make a connection between everyday responsibilities and mathematics. It is difficult to find mathematical experiments for teachers and I hope to create a unit that can be utilized by many teachers throughout New Haven and other school districts.

For the past two years, I have enjoyed the opportunity of teaching in the New Haven Public School System. Last year, I taught middle school math at Wexler Grant Community School, a K-8 school. Approximately 96% of the students were minority. Many students had difficulty relating to complex topics. We spent lots of time with hands on projects to increase their confidence. I currently teach Pre-Algebra, Geometry and Algebra II at Metropolitan Business Academy. Many of my students struggle to connect mathematics to the real world.

Why do I need math? Metropolitan Business Academy is an inter-district magnet high school in New Haven. 90% of our population is minority. Our average SAT mathematics score is approximately 400, over 100 points less than the state average. We only have 32% of our sophomores proficient in mathematics on the Connecticut Aptitude Performance Test. Lots of our students are pursuing careers in Business. Many of these students have never scored well on any standardized tests. The intent of this unit is to have students make the connection between mathematics and the real world, which in turn will help them improve their poor standardized test scores.

Within the context of Algebra Lab we will answer important questions about ratios and proportions within recipes. Is ½ larger than ¼? What happens when you double a recipe? What happens to the measures of the ingredients when you only need ½ of a recipe? How is cooking time effected by the size of the pan?

We can offer a look at linear expressions. Students will predict what the temperature of boiling water will be after a long period of time given that in the early stages water increases in temperature linearly. We can also ask what the effects of salt in water to compare graphs. We can ask why Alfredo sauce and tomato sauce boil at different temperatures.

The area of mathematics in which we discovered the most examples that related to cooking was Geometry. Students compared volumes of unbaked items and volumes of baked items in a pan. They then compared the mass and volume of cooked baked goods versus uncooked baked goods (i.e. batter).

I am attempting to link more subject areas with mathematics. These lessons will utilize the science of cooking to explain and learn mathematics. Students will do hands-on activities to discover truths and use the scientific method or our problem solving rubric to explain our outcomes.

I decided to write my unit for the students that need them the most. I have selected my algebra lab students. These are students who have not had much success in mathematics and have continually scored poorly on the Connecticut Mastery Tests. These students are the ones who have not seen much success in school and have difficulty pushing themselves to higher standards. I want them to continually challenge themselves by organizing information, interpreting the information.

I plan for the students to form conjectures or predictions and test the results. It is so important that they look at the information needed to predict what is going on. Within these rules we hope to explain the science behind cooking.

My goal is for students to have success in math, to force them to use their brains and lastly to give them the life skill/ability to make a meal from start to finish.

Section Two: Background Information on the lessons

I have compiled four lessons that are fairly contiguous but require a minor amount of support (i.e. direct instruction and guided practice) in between. The titles are follows: Tomato Sauce, Boiling Pasta, Playing With Dough and Brownies. This unit is designed to give the life skills to students while allowing them a visual connection to mathematics.

Background Tomato Sauce

Through the internet and website www.foodnetwork.com I was able to compile a list chart of marinara sauces from around the country and authored by some of the most popular chefs in America. The prior lesson to tomato sauce will talk about measures of central tendency. We will use mean, median or mode to decide what ingredients will determine the "perfect marinara sauce." Below I have 2 charts. The first chart consists of the vegetables and other main ingredients in the marinara sauce while the second one consists of the herbs and spices in the sauce.

Big Ingredients in the Marinara Matrix

	tomatoes	tomato paste	extra virgin olive oil	garlic	Spanish onions	Carrots	celery
Michael Chiarello	4 cups		2 tbsp	3 cloves			
Anne Burrell	4 cans		1/4 cup	4 cloves	2 large		
Tyler Florence	1 can		2 tbsp	2 tsp	1 medium		
Ralph's of Philadelphia	3 cans	3 tbsp	1 cup	8 cloves	1 large		
Emeril	3 cans		1 tbsp	2 cloves	1 medium		
Nona's (Danny Boome)	1 can	2 tbsp	1/4 cup	5 cloves	1 large	3 full	
The Big Dipper	1 can		1 tbsp	3 cloves			
Guida De Laurentiis	2 cans		1/2 cup	2 cloves	2 small		2 stalks

Herbs and Spices in Marinara Matrix

	Italian parsley	basil	oregano	bay leaf	salt	pepper	red pepper
Michael Chiarello	1 tbsp	1 tbsp			1 tsp sea salt		
Anne Burrell					1 tsp kosher salt		
Tyler Florence		1 tsp	1 tsp	1 dried	pinch	pin ch	
Ralph's of Philadelphia	1/2 cup	1/2 cup	1 tsp		1 1/2 tbsp	1 tsp	
Emeril	2 tbsp		1 tsp				
Nona's (Danny Boome)		1 cup	2 tbsp		1 tsp	1 tsp	
The Big Dipper	1 tbsp				1 tsp	1 tsp	1 tsp
Guida De Laurentiis				2 dried	1/2 tsp sea salt	1/2 tsp	

Once we each decide what our marinara sauce will consist of, we will combine the elements so that we can graph and plot the outcomes along our graph. The goal of the lesson is to plot points on the Cartesian plane and use this information to make predictions on where the graph will continue. A little back ground information on the coordinate plane and Rene Des Carte is in order here.

Rene Des Carte

In the 1600s a French mathematician and philosopher discovered the most important tool for our unit of graphing and plotting points, the coordinate plane Prior to this invention, a geometric figure would be created and the parts of it would be defined from it With the discovery of the "Cartesian Plane," Rene Des Carte could define or describe things prior to the figure being established.

Most of Des Carte's work can be located in three of his books He felt that only mathematics was certain, so all in the world must be based on mathematics In La Dioptrique, Des Carte studies optics This book did not discuss anything new, it experimented with past beliefs Another book Les Meteores is a book on meteorology It is the first book to study weather as a science, although many of his conjectures were inaccurate The most important book we would like to look at is La Geometrie Within this book Des Carte wrote about:

1. The first step toward invariants.
2. Recognition of Geometry through Algebra.
3. Importing Algebra into Geometry.
4. How we can solve many previously unsolved Geometric problems using Algebra.

The Cartesian Plane

The Cartesian coordinate system is arguably the best tool for mathematicians studying Geometry. It is a series of vertical parallel lines that are perpendicular by an infinite number of horizontal parallel lines forming a "grid." The axis that separates the positive vertical lines from the negative vertical line is called the y-axis. The axis that separates the positive horizontal lines from the negative horizontal line is the x-axis. The location where the x-axis and y-axis intersect is called the origin. We name the points (x, y) when they are in coordinate form.

In our problem we are charting the temperature of sauce over a period of time. Our x-values are our independent variable. We will use time and measure the temperature every minute. Our dependent variable, temperature, will be our y-values as the temperature of the water will depend on the time it is measured.

Interpolation

Throughout the lesson, we want our students to be able to make predictions based on the material put in front of them. The lesson is intended to teach students that the water will rise at a relatively consistent basis until it reaches the boiling point. Through experiments with the young adults, we had a wide range of responses. We had students who knew that the graph would level out and reach a maximum value. Some predicted it to be around 90 ^{0} Celsius while others made the proper prediction of 100 ^{0} Celsius. Some students figured it would continue with a positive slope indefinitely. It is important for the students to be able to explain why they were either right or wrong.

First Published Interpolator

William Playfair, a Scottish political economist wrote a book, The Commercial and Political Atlas. All forty four of Playfair's graphs were time-series graphs. This is very similar to the time-series in our above experiment. His main purpose was to show the imports and exports of Scotland during the 1700s to multiple countries. He liked to combine political and other important information in his graphs as he felt that time alone did not fully explain the data. Our graphs can fully be explained using our two variable theme.

Boiling pasta background

My second lesson answers the question posed by an Old Italian wise tale, "Do we put salt in water to change the temperature of the water?" The first couple of attempts at this lesson were not successful. After the third time, the students were able to answer the question. It took a lot of salt to raise the temperature of water four degrees Celsius. The taste of the pasta was poor. We came to the conclusion that the salt in water is used for taste not to raise the temperature.

Slope and y-intercept

Our academic goal of this lesson is to take the information that we charted and be able to explain the information using a linear equation. The popular method that has been used throughout the world in the slope-intercept formula or $y = mx + b$ (m is the slope of the line and b is the y-intercept). The slope of the line is the description of "how fast or slow it is increasing or decreasing." The y-intercept is the value when our line intersects the y-axis.

We start with water at room temperature; which was approximately 60^{0} Celsius. This is our first measurement. When we begin, our first measurement is assigned zero, signifying the starting point. Our y-intercept (b) will be approximately 60^{0}. In order to get a positive slope in our graph, we place the water on a heating element. In order to get a negative slope to our graph, we add ice to the water. In order to get a line of best fit with no slope, the temperatures of the water will be 0^{0} or 100^{0}. It is important that they can recall back from the Tomato Sauce lesson to help identify these ideas.

Origins of Lines and Spatial figures

In order to learn more about the origins of lines and linear equation, let us take a look at the mathematicians that led us to this point. In the paper, I will try to link the work of the mathematicians to the development of analytic geometry and the interpolation of linear equations. The last 2 lessons deal with many topics in number theory, ratios, proportions, area of planar figures and volumes. The next part discusses the foundations to the formulas that we still use today.

Euclid

Everything that deals with geometry can lead us back in time to Euclid. Euclid was a famous Greek Mathematician from Alexandria. "The father of Geometry" completed his work over 2200 years ago around 300BC. During this time he wrote arguably the most influential mathematics book of all time, The Elements. The Elements described the most basic parts of Geometry and used these descriptions to define all other terms that we commonly use today Within these thirteen books, Euclid was able to write down his findings that we use as a basis for teaching Geometry today. A man of great wisdom, he was able to organize his thoughts while working in the Great library of Alexandria.

Elements Book I

The basis for all Geometry is that we start with the 3 undefined terms; point, line and plane and use these terms to define everything else that exists. Euclid is able to describe a point, line and plane, this will illustrate our understanding of Euclidean Geometry He stated: A point is that which has no part In other words, a point has no size, it is used to mark a location He then states: A line is a breathless length He is saying that it is a length with no width It is used to describe the distance from one place to another. His last undefinable term is a plane. He uses the term surface: a surface is that which has length and breadth only. For more understanding, he is saying that. a plane or a surface is flat similar to a wall, ceiling or floor In Book I, he completes his work by describing parts of lines, figures, angles, and circles Within this book, Euclid also writes a large part on equality and the basis of number theory.

Elements Book II

It starts the ideas of Geometric Algebra by establishing the ideas of planar Geometry; Euclid is able to explain the use of series and sequences while multiplying by another number and he described quadratics as an example of area. If x is the length of a side and y + z is the length of a different side then when we multiply by a common width then the area of the two shapes will be the same. Example: If $x = y + z$, then $x^2 = xy + xz$ or if $x = y + z$, then $xy = yz + y^2$ or if $x = y + z$.

Elements Book III

Euclid writes about circles He describes the properties of tangents, arcs, arc lengths and sectors. Much of this book is important but does not directly help us to understand the development of graphing and lines.

Elements Book IV

This book focuses on planar figures. Within this book, Euclid writes about inscribes and circumscribes figures and their relationships. This is an important concept as we move into our last two lessons, but has very little to help us with our interpretation of graphs.

Elements Book V

This book has a large portion of number theory "The Father of Geometry" wrote about ratios and proportions. He discussed using a common multiple, the associative property and inverse proportions. This book was necessary as we study the Elements further, it allows us to use these rules when we discuss book VI

Elements Book VI

This teaches us the properties on planar Geometry that requires the applications of ratios and proportions. This book has a large focus on figure similarity. It also allows us to use book V when discussing the ratios of angles and circumferences.

Elements Book VII

Euclid's most important book on number theory. It discusses numbers, even and odd, prime and relatively prime, proportion, and perfect number. It also defines units, parts and multiples. Euclid's most fascinating work in this book was done with a decreasing sequence. He stated that it could not be infinite when he was using whole positive numbers.

Elements Book VIII

This piece is important to this section as it deals with ratios and proportions within geographic progressions.

Elements Book IX

It continues on the geometric progressions and shows us how to sum of any number of geometric series. This book also contains various types of applications found from using the rules of the past two books.

Elements Book X

Euclid deals with the theory of irrational numbers. This concept is way before his time.

Elements Book XI

Book XI is used to set in motion books XII and XIII It provides the definitions necessary for the rules in the next two books He then used the same structure of rules for solids as he did with planar figures.

Elements Book XII

Euclid goes into detail about the relationships of three dimensional shapes or solids It starts by telling us about the relationships of circles and spheres are related to the square and cube of their diameters It then goes into detail describing relationships about the parts of prisms, pyramids, spheres, cones and cylinders It tells us how to calculate the relative the relative volumes.

Elements Book XIII

The Elements ends with book XIII Euclid discusses the properties of the five regular polyhedra and gives a proof that there are precisely five

To sum up Euclid gave us the foundation to describe lines and work with them He talked about relating distances to areas and other functional ideas Most of all he talked about common ratios, we can say his work with the decreasing sequence in book VII can be the pre-work for slope.

Pythagoras

Pythagoras was another Greek mathematician He lived around 500 BC, two hundred years prior to the work of Euclid Pythagoras was not only a great mathematician, he was a philosopher and astronomer. Pythagoras linked his mathematics to philosophy, music and astronomy He was interested in the concepts of number theory, mathematical figures and the abstract idea of a proof.

Pythagoras had six main contributions to mathematics and the sciences:

1. In astronomy, the Earth was a sphere at the center of the Universe. He also recognized that the orbit of the Moon was inclined to the equator of the Earth He was one of the first to realize that Venus as an evening star and as a morning star was the same planet.
2. He discovered the five regular solids

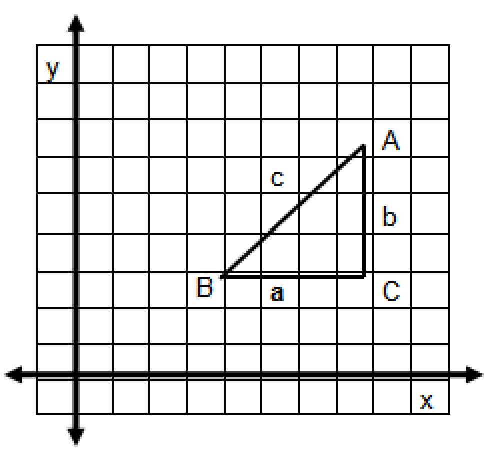
a. Tetrahedron
b. Octahedron
c. Icosahedron
d. Hexahedron (cube)
e. Dodecahedron

3. The discovery of irrationals Because of his belief that all things are numbers, it would be logical to prove that the hypotenuse of an isosceles right triangle had a length corresponding to a number.
4. Constructing figures of a given area and geometrical algebra. This is a skill that we find very important in the modern day teaching of geometry.
5. The sum of the angles of a triangle is equal to two right angles. Also the sum of exterior angles is equal to four right angles. We use. numerical values of 180^0 and 360^0 for each of these statements
6. The Pythagorean Theorem- For a right triangle the area of the square on the hypotenuse is equal to the sum of the areas of the squares on the other two legs (The square on the hypotenuse would not be thought of as a number multiplied by itself, but rather as a geometrical square constructed on the side.)

The Pythagorean Theorem was used by both the Babylonians and Egyptians for thousands of years but it wasn't until Pythagoras proved it did it get its due recognition in "the western world." He found the sum of the area of the two squares is equal to the area of the third square meant that the two squares could be cut up and reassembled to form a square identical to the third square.

Using the coordinate plane and adapting the teachings of Pythagoras, We can find the distance between any two coordinates (x_1, y_1) and (x_2, y_2). The distance formula:

$d = ((x_2 - x_1)^2 + (y_2 - y_1)^2)^{1/2}$. We can show this in the diagram below showing the Pythagorean Theorem in the Cartesian plane. We want to find the distance between Point A and Point B.



In order to find the distance from point B to Point A we need to Place C on the graph such that it forms a right triangle with points A and B. According to the graph above Point B has a coordinate of (4, 3) and Point A has a coordinate of (8, 6) and point C has (8, 4)

The distance of a = $(x_2 - x_1) = (8 - 4) = 4$

The distance of b = $(y_2 - y_1) = (6 - 3) = 3$

$c^2 = a^2 + b^2$ $d = ((x_2 - x_1)^2 + (y_2 - y_1)^2)^{1/2.}$

$c^2 = 4^2 + 3^2$ $d = ((8 - 4)^2 + (6 - 3)^2)^{1/2.}$

$c^2 = 16+ 9$ $d = (4^2 + 3^2)^{1/2.}$

$c^2 = 25$ $d = (16+ 9)^{1/2.}$

$c = 5$ $d = (25)^{1/2} = 5$

Within this tool, Des Carte made simple rules for the Euclidean Transformations:

1. Translation is a movement or slide along the coordinate plane.
   = (x + X, y + Y). Where X and Y are the distances of the shift.
2. Reflection (x, y) is (-x, y) if reflected across the y-axis
   Reflection (x, y) is (x, -y) if reflected across the x-axis
3. Rotation (x, y) around the origin by some angle A.
   X' = xcosA - ysinA
   Y' = xsinA - y cosA
4. Dilation is to make object bigger by a scale factor (m)
   (x', y') = (mx my)

Al-Khwarizmi

Across the world approximately one thousand years after the work of Euclid, Al-Khwarizmi wrote a book The Calculations By Completion and Balancing Around 800 Al-Khwarizmi studies at the House of Wisdom located in current Baghdad His work led to great understandings in mathematics, astronomy and Geography He developed trigonometric tables containing the sine function His work also led him to the concept of differentiation in Calculus His work in Geography led to the first map of the known world. He was able to adopt the number zero from readings of Hindu and Greek Mathematicians

The Calculations By Completion and Balancing changed algebra to date The first half of Al-Khwarizmi's book discussed linear and quadratic terms The second part of his book focused on the business and applications of his work He gave examples of linear and quadratic equations into six standard forms.

1. Squares equal to roots $10x^2 = 20x$
2. Squares equal to numbers $10x^2 = 25$
3. Roots equal to numbers $10x = 20$
4. Squares and roots equal to numbers $x^2 + 10x = 39$
5. Squares and numbers equal to roots $10x^2 + 39 = 10x$
6. Roots and numbers equal to squares $10x + 39 = x^2$

All of his work was done spoken and not in the form that we have used in bold above to help us understand the wording. Because he was able to teach algebra in such a basic model, Al-Khwarizmi is labeled "the father of Algebra." This led to more people studying algebra around the world.

Volume and Surface Area

The next two lesson plans have an emphasis on volume and surface area. The four shapes that we will use are cube, rectangular prism, cylinder and sphere. The sphere will only be used for the advanced students. The students will be introduced to the formulas and expected to solve problems using them. In the lesson, Playing with Dough, students will be asked to manipulate dough into the solids above. They will need to measure the dimensions, plug them into the formulas and solve for the volume.

The volume of an object is the measurement of the space an object occupies. To describe volume, it is the measurement "inside of the figure." The formulas for volume are listed below:

1. Volume of a cube = side x side x side. (side is the length of any edge of the cube)
2. Volume of a cylinder = Π x radius squared x height
3. Volume of a rectangular prism = length x width x height
4. Volume of a sphere = 4/3 Π x radius cubed

The Surface area of an object is the planar measurement of the shape. The surface area is considered the measurement of the area of "the exterior of the shape." There are two methods of finding surface area. One method is effective when working with pyramids and prisms, while the other method is always effective. The first method is to find the area of the planar sides of the solid and add them together. The second method is to utilize the formulas listed below.

1. Surface area of a cube = 6 x side x side
2. Surface area of a cylinder = 2Π(radius squared + radius x height)
3. Surface area of a rectangular prism = 2(length x width + length x height +width x height)
4. Surface area of a circle = 4Π x radius squared

Section Three: Lesson Plans

Tomato Sauce: Plotting, Interpolating and Determining Slope

Prior lesson

We will use the marinara sauce matrix to make the "perfect marinara sauce." We will look at all the recipes and decide what we feel is essential and

Summary of Lesson:

This lesson is designed for students to see a real world application of graphing lines. They will create lines from the data that are measuring. We will use this data to show the slope of a line. The slope will either be increasing or a slope of zero. We also hope to show that even though steam is coming out that the water remains at 212 ^{0} F or 100 ^{0} C. Both of the samples reach a maximum temperature. The previous lesson is on plotting points and understanding what the graph looks like. We will have completed what is increasing or decreasing.

Equipment necessary:

- °¤ Water source
- °¤ Range or heating element
- °¤ Thermometer for each group
- °¤ Pan for each group
- °¤ Agreed upon sauce ingredients (5 cups for each group)

Objectives: SWBAT (Students will be able to)…

- °¤ Document the temperature over time.
- °¤ Predict the graph based on their data.
- °¤ Communicate that the slope of the line relates to the change of the temperature over time.
- °¤ Communicate that the starting time is time 0.
- °¤ Compare results from the pasta sauce to the results from the water.

Warm-up:

The students will be asked to draw lines that increase, decrease and have no change. We will explain independent and dependent variables.

Lesson:

- °¤ Turn on the range to a common setting and use the same range for all experiments.
- °¤ Students will combine ingredients to make the "perfect marinara sauce."
- °¤ Students will let it cook and start second experiment.
- °¤ Measure 5 cups of water into a sauce pan given to you.
- °¤ Measure the temperature every minute for 10 minutes for each pan.
- °¤ Make a prediction of what they think the graph will look like in colored pencil.
- °¤ Continue measuring until the water boils. Put a B on the graph at the time the water boils.
- °¤ Make a second prediction based on what the graph looks like.
- °¤ Measure again for 5 more minutes
- °¤ Answer questions before continuing

1. Explain the graph with respect to temperature over time.
2. Were there any differences in your predictions?
3. Do you think water will get any hotter than 212 ^{0}F or 100 ^{0}C?
4. What was the temperature at time 0?
5. Explain what happens to the graph up to 212 ^{0}F or 100 ^{0}C?
6. What happened to the graph when the water boiled?
7. Make a prediction on whether water boils at a higher temperature then tomato sauce.

Challenge questions:

8. Why do most recipes call for water at 212 ^{0}F or 100 ^{0}C?
9. Does the size of the pan or the range effect the time needed to make the water boil?
10. Do you think how we define boil will affect our answers?

- °¤ Students will measure five cups of pre-made sauce into a pan.
- °¤ Measure the temperature until the sauce boils. Put a B on the time it takes to boil.
- °¤ Continue measuring for 5 minutes.
- °¤ Turn off before it burns!
- °¤ Answer questions before continuing

1. Was your prediction from question 7 correct?
2. Did they both start at the same temperature?
3. Did they both boil at the same temperature?
4. Compare the graphs of the water and sauce with respect to time.

Challenge questions:

5. If we started at the same temperature would it take less time, more time of the same time to boil? Explain your reasoning.
6. Why do you think sauce boiled at a different temperature?

°¤ We will use the first sample to describe a linear equation. We will use the

equation y = mx + b. b would be the place where we started and m is the slope.

Slope is the change in y over the change in x. We increased 15 degrees in 5

minutes. So our slope is 3 degrees per minute.

1. What is the b in our water data? Sauce data?
2. What is the slope in our water data? Sauce data?
3. When the water or sauce boils what is our slope?

°¤Clean up and hand in your lab report.

Lesson Plan Boiling Pasta

Prior Lesson

We will work on graphing lines using y = mx + b.

Summary of Lesson:

The lesson will discover the truth of an Old Italian cook that says, "We add salt to water to increase the temperature that the pasta boils." Students will boil water again using a similar approach to the sauce comparison lesson plan. They will then document the time and temperature at which time the water boils with and without salt. We will do this experiment a couple of times.

Equipment necessary:

- °¤ Water source
- °¤ Range or stove top
- °¤ Thermometer for each group
- °¤ Pan for each group
- °¤ strainer
- °¤ Salt
- °¤ pasta

Objectives: SWBAT…

- °¤ Plot the temperature on a graph
- °¤ Predict the graph based on their data after 10 minutes.
- °¤ Communicate that the slope of the line relates to the change of the temperature over time.
- °¤ Compare their data with the sauce boiling experiment.
- °¤ Write an equation for the water over time.
- °¤ Compare results from the salted water to the results from the water.

Warm-up:

Students will graph lines using y = mx + b

Lesson:

- °¤ Turn on the range to a common temperature and use the same range for all experiments.
- °¤ Measure 4 cups of water into a sauce pan given to you.
- °¤ Measure the temperature every minute until the water boils for 5 minutes.
- °¤ Add 1 cup of pasta to the water for ten minutes
- °¤ Measure the temperature of the water immediately after the pasta was inserted.
- °¤ After 10 minutes drain the pasta.
- °¤ Answer questions before continuing

11. What happened to the water when we added pasta? Why
12. Do you think water will get any hotter than 212 ^{0}F or 100 ^{0}C after we added the pasta?
13. Make a prediction on whether water boils at a higher temperature when

we add 4 teaspoons of salt?

14. Taste the pasta and make observations using all 5 senses.

Challenge questions:

15. What do you think would happen to the temperature of the water if we added 2 cups of pasta?
16. What do you think would happen to the temperature of the water if we started with 20 cups of water?
17. Does the ratio of pasta to water make a difference in the boiling process?

°¤ A second group will repeat the above steps of the experiment with 4 teaspoons of salt.

°¤ Measure 4 cups of water and 4 teaspoons of salt into a sauce pan given to you.

°¤ Measure the temperature every minute until the water boils for 5 minutes.

°¤ Add 1 cup of pasta to the water for 10 minutes.

°¤ Measure the temperature of the water immediately after the pasta was inserted.

°¤ Answer questions before continuing

7. Did it boil at the same time?
8. Did both samples start at the same temperature?
9. Did they both boil at the same temperature?
10. Compare the graphs of the water and salt water. What are similar and what is different?

Challenge questions:

11. Did both graphs have a common slope prior to boiling?
12. Compare the taste of the pasta with salt and without salt? Which was more pleasant?

- °¤ The third group will repeat the experiment again with 1 cup of salt.
- °¤ Measure 4 cups of water and 1 cup of salt into a sauce pan given to you.
- °¤ Measure the temperature every minute until the water boils for 5 minutes.
- °¤ Add 1 cup of pasta to the water for 10 minutes.
- °¤ Measure the temperature of the water immediately after the pasta was inserted.
- °¤ After 10 minutes drain the pasta.
- °¤ Answer questions before continuing

1. Did it boil at the same time as the last two?
2. Did they both boil at the same temperature?
3. Compare the graphs of the water and 2 salt water experiments. What are similar and what is different?
4. Write the equation of each line (up until the boiling point).

Challenge questions:

5. Make some observations on the pasta with 1 cup of salt.
6. The question we started with was an Italian woman claimed "adding salt to water increased the temperature at which pasta boils. Is this accurate? Explain.

- °¤ There is truth that salt will raise the temperature that water boils but not enough to make a difference. Too much salt alters the taste of the pasta.
- °¤ Let's start with water at room temperature and add ice. Repeat experiment.
- °¤ Clean up and hand in your lab report.

The next lesson:

We will work on the temperature scales.

Lesson Plan Playing with Dough

Prior Lesson

We will discuss the background of the Fahrenheit scale and the Celsius scale. We will convert from Fahrenheit to Celsius and vice versa.

Summary of Lesson:

We will make homemade dough to investigate the formulas of volume. We will solve as many open ended problems regarding surface area and volume.

Equipment necessary

- °¤ Water source
- °¤ Salt, Flour, Cream of tartar
- °¤ Measuring cups and spoons
- °¤ Butter, olive oil
- °¤ 3 types of breads

Objectives: SWBAT…

- °¤ Measure the ingredients
- °¤ Manipulate the dough to find the volume and surface area by shaping it into cylinders, cubes and rectangular prisms.
- °¤ Compare measurements.
- °¤ Make conjectures.
- °¤ Test conjectures.

Warm-up:

We will review the formulas for volume and surface area of cylinders, cubes and rectangular prisms.

Lesson:

- °¤ Follow the recipe to make dough to play with.
- °¤ Find the surface area and volume of the dough in different shapes.
- °¤ Manipulate the dough into a rectangular prism, measure the length, width and height.

- °¤ Find the surface area and volume of the dough.
- °¤ Manipulate the dough into a cube, measure the length, width and height.
- °¤ Find the surface area and volume of the dough.
- °¤ Manipulate the dough into a cylinder, measure the length, width and height.
- °¤ Find the surface area and volume of the dough.

Challenge questions:

Given a length and a width of a rectangular prism, predict the height.

Given a diameter of a cylinder, predict the height.

Predict the radius of a sphere.

The next lesson:

Students will work on volume and surface area questions in groups.

Lesson Plan Brownies

Prior lesson:

We will be on the common ratios that we use and the visual representations. We will also compare ratios.

Summary of Lesson:

We will bake brownies. We will try to cut the recipe in half and double it using scale factors. We will compare volumes along the way.

Equipment necessary:

- °¤ Water source
- °¤ Oil, eggs and brownie mix
- °¤ Pans for each group to bake brownies and oil for pans.
- °¤ Measuring cups, oven mitts, mixer
- °¤ Knife to cut brownies, plates

Objective:

- °¤ Students will measure the brownie mix
- °¤ Students will solve for the volume of the brownie mix
- °¤ Students will measure the mass of the brownie mix in grams.
- °¤ Students will compare measurements

°¤ Students will identify ratios
°¤ Students will solve problems using ratios

Warm-up:

We will work on common ratios to solve basic problems. You must give ½ of your money to the owner. You received $ 100. How much does the owner get? These are simple word problems and we want the students to feel confident at the start. We will also compare ratios (greater than / less than).

Lesson:

°¤ Set oven to 350 ^{0} F.
°¤ Measure the mass of the empty brownie pan on the scale.
°¤ Look at the recipe on the back and answer the questions before continuing.

1. How much oil do we need if we double the recipe?
2. How many eggs do we need if we double the recipe?
3. How much oil is needed if we cut the recipe in half?

°¤ Mix the ingredients.
°¤ Place in pan.
°¤ Measure the mass of the brownie mix on the scale.
°¤ Find the volume of the brownie mix uncooked.
°¤ Bake brownies.
°¤ Let brownies cool for 15 minutes.
°¤ Find the volume of the brownie mix cooked.
°¤ Answer questions before continuing:

18. What was the volume of the raw brownie mix?
19. What was the volume of the cooked brownie mix?
20. What was the ratio of the volume of the cooked brownie mix to the raw brownie mix?
21. What is the mass of the brownie mix before cooking?
22. What is the mass of the brownie mix after cooking?
23. Did the volume change?
24. Did the mass change?

Challenge questions:

25. What do you think is happening to make the bread expand?
26. Cut out a brownie. Explain why the mass of the brownies did not change

but the volume changed.

°¤ Students will double the recipe and repeat the process above.

13. Compare the results in chart.
14. Does anything in the chart surprise you?

°¤ Cut the brownies in half.

°¤ Cut the half in half again.

°¤ Cut it in half again?

°¤ What is the ratio of that piece to the total pan of brownie?

°¤ Enjoy the brownies and share them with your classmates.

The next lesson:

We will multiply ratios and solve word problems by multiplying ratios.

Appendix

According to the State of Connecticut Mathematics Curriculum Framework, my lessons will meet the following standards listed below.

Number Sense Operations Estimation and Approximation Ratio, Proportion and Percent: Numerical and Proportional Reasoning - Quantitative relationships can be expressed numerically in multiple ways in order to make connections and simplify calculations using a variety of strategies, tools and technologies.

Measurement Spatial Relationships and Geometry: Geometry and Measurement - Shapes and structures can be analyzed, visualized, measured and transformed using a variety of strategies, tools and technologies.

Probability and Statistics Discrete Mathematics: Working with Data - Data can be analyzed to make informed decisions using a variety of strategies, tools and technologies.

Bibliography

Barham, Peter. The Science of Cooking. New York: Springer, 2001.

McGee, Harold. On Food and Cooking: The Science and Lore of the Kitchen. 2nd . New York: Scribner, 2004.

Wolke, Robert L. What Einstein Told His Cook: Kitchen Science Explained. 1st. New York: W. W. Norton & Company, 2002.

Wolke, Robert L. What Einstein Told His Cook 2: Further adventures in Kitchen Science. 1st. New York: W. W. Norton & Company, 2005.

Tufte R. Tufte. The Visual Display of Quantitative Information. 1 st Cheshire, Connecitcut: Graphics Press, 1983

Wikipedia. 2001. http://en.wikipedia.org/wiki/euclid (accessed June 2009).

Wikipedia. January 10, 2001. http://en.wikipedia.org/wiki/descarte (accessed June 2009).

Wikipedia. January 10, 2001. http://en.wikipedia.org/wiki/Cartesian_coordinate_system (accessed June 2009).

Wikipedia. January 10, 2001. http://en.wikipedia.org/wiki/Al-Khwarizmi (accessed June 2009).

Wikipedia. January 10, 2001. http://en.wikipedia.org/wiki/Pythagoras (accessed June 2009).

D.E. Joyce, Clark University, 1998. http://aleph0.clarku.edu/~djoyce/java/elements/elements.html (accessed June 2009)

Food Network. January 10, 2009. http://www.foodnetwork.com/search/delegate.do?fnSearchString=marinara+sauce&fnSearchType=site (accessed June 2009).