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The Math and Science of Kitchen Ratios

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Introduction

In the kitchen, sometimes measurements need not be so precise: a pinch of this, a dash of that, or the common phrase “to taste”. Ask any grandma how to make a family dish and I guarantee that while the ingredients and process are very specific, the measurements are not. Baking is the one exception to cooking. Baking is the art of precision and the reasoning behind the necessity of precision is simple math and some chemistry. The differences in technique, ingredients, and measurements can make a ball of dough for bread, or something that feels like a rock.

Every culture in the world has their version of the pancake. There’s the French crepe, Korean Pa Jun, Navajo abe neezmásí, Austrian Kaiserschmarrn, Australian Pikelets, South African Pannekoeke, Greek Tiganites, Japanese Okonomiyaki, Malaysian Apam Balik, Nicaraguan Manuelitas, Russian Olady, Ethiopian Injera, Venezuelan Cachapas, Dutch Babies, Salvadoran Pupusas, Colombian Arepas, North Indian Dosa, South Asian Roti, Danish Aebleskiver, Italian Farinata[1] , Filipino Bibingka, American Buttermilk Pancakes and family versions of all of these such as Rosa Parks’ “Featherlite Pancakes”[2] . But what do all of these pancakes have in common? They are all made up of a mixture of some sort of starch, fat, liquid, and other regional ingredients.

My family immigrated to this country from the Philippines, and I grew up eating pancakes from a boxed mixture. But what makes a pancake mix? Now, I don’t proclaim myself to be a chef. In fact, I only cook or bake out of necessity. Eating is more my thing. When it comes to eating, just like Goldilocks, I have my preferences on how I like my dishes, just right. Like many immigrant families, my family’s attempt at an American breakfast included pancakes. My family loves pancakes...from pancake mix. What ingredients make the pancakes just right?

The purpose of this unit is to bridge math and science concepts to examine the ratios in cooking pancakes around the world. This unit is aimed toward sixth grade students and will best work in a cored math and science block or in a self-contained classroom.

Rationale

Berkeley is home to one of the consistently rated top universities in the world. The district is considered a corridor district, serving students in cities to the north and south, which brings diversity to our student population. However, nearby is a large public university and the technology industry; this dichotomy creates a gap between our most and least privileged students. The student population of Martin Luther King Jr. Middle School reflects the diversity of the Bay Area. King is a large urban middle school, which houses the district's Newcomer Program for English learners who have been in the country for less than a year. In my classroom alone there are more than six languages spoken at home. 35% of the student population qualifies for free and reduced lunch. The school setting is a departmentalized sixth through eighth grade; however, the sixth grade is cored for humanities and math/science; my students meet for a 90 minute block period, five days a week. During this block period, math/science core teachers have the flexibility to teach the math and science content by day or by splitting the time period by subject; however, the demand for math assessments has left little time for science. Currently, the district just finished its second year of the new science standards rollout, beginning with sixth grade, with 2018 being the first year of full implementation of the Next Generation Science Standards (NGSS). The district is in its 5th year in implementing Common Core State Standards (CCSS) and the current curriculum adoption is Eureka Math's *A Story of Ratios*.

This unit is a math and science unit that can be taught in a math and science core class or self-contained classroom. As a math and science core teacher, it is often hard to fit in all the content when one subject is more heavily scrutinized by assessments. Science ends up coming second to math lessons and this unit is a way to bring science into middle school math in an engaging, culturally responsive way.

In the past, I have taught this ratios unit straight from the textbook. The unit starts with how to write ratios (using a colon, words, as a fraction) and then goes into the different models of ratios. I would bring concentration problems that examine how "chocolatey" milk is by examining the ratios[3] or the Mathematics Assessment Project Formative Assessment Lesson "Using Proportional Reasoning" to supplement the adopted curriculum, but nevertheless, the lessons were still pencil and paper problems, no matter how higher level the problems were. Additionally, the math was taking most of the block and completely separate from the science. This thematic unit seeks to address the inequality of time spent on science in classrooms.

Content

Reactants and Products

Liquids

There is a reason behind each of the ingredients in pancakes. The reactants, or raw food, are combined and processed in creative ways to make the product, or cooked food. Liquids, for example, are used to change the texture in foods. Water is present in almost all foods unless it removed for a reason.[4] Liquids hydrate the proteins required for the gluten formation and also are important because they dissolve hydrophilic ingredients such as sugar, salt, and leavener. In this section, I will discuss the three main categories of food: carbohydrates, fats, and proteins.

Carbohydrates

Carbohydrates, or molecules made of carbon and water, are abundant in nature and food. "Carbohydrates may be used as sweeteners, thickeners, stabilizers, gelling agents, and fat replacers."[5] There are four categories of carbohydrates: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. Carbohydrates are important for many reasons. One reason is they provide energy, 4 calories per gram[6] , for the digestible carbohydrates. Indigestible carbohydrates, such as cellulose, are an important dietary fiber.

Maltose, an example of a disaccharide, is the building block for starch, a polysaccharide. Starch is the main ingredient all pancakes around the world have in common. It is a plant polysaccharide and necessary for nervous system functioning.[7] Starch can come from wheat, rice, grains, roots, tubers, legumes, and even fruit, such as bananas. The molecular structure of starch also allows for the foods to maintain their structure.[8] Similarly, this characteristic is the exact reason why starch is added to thicken sauces, soups, or dressing. It can be used as a stabilizer or thickener.

Fat

Fat contains 9 calories per gram, which is probably why recommended daily values are less for fats than they are for carbohydrates. Fat changes batters to make them either more chewy for noodles or crumbly for a pastry.[9] The oil used to make pancake batter assists both in retaining moisture and trapping the gas:

> Fats and oils shield gluten protein from water, thus physically interfering with the hydration needed for gluten development. Both fats and oils tenderize baked products by coating, although oil (liquid at room temperature) coats more completely and yields a more tender product than solid fats; if coating is extreme, the texture of the product will be mealy, and the dough will show reduced gluten formation. Fats containing emulsifiers help water and fat to mix and may promote the stretching of gluten strands, yielding a higher volume of the baked product.[10]

Some recipes, like Rosa Parks' recipe above, call on shortening as the fat ingredient. Shortening can be either a vegetable oil, or unsaturated fat, or butter, a saturated fat. At room temperature, saturated fats are solid and unsaturated fats are liquid. In a saturated fat molecule, every carbon is bonded to a hydrogen and the shape is straight, making it very it very easy to pack many of these molecules together. Hydrogenated oils such as margarine or Crisco also have this molecular structure and are considered saturated fats. Because of their molecular structure, unsaturated fats are liquids and therefore won't clog your arteries as easily. 9 calories per gram or not, no one prefers a dry or dense pancake. Fats are important!

Proteins

Proteins, which are made up of amino acids, comprise the muscular system of animals.[11] The molecular structure of proteins is the most complex.

In the pancake, the egg is the protein and binding agent that holds all the ingredients together, assisting with maintaining the structure of the pancake by trapping air.[12]

Additives and Other Ingredients

Some additives are included to make the consistency of the pancake even more desirable; for many people this means fluffy (crepe lovers, this section isn't for you). To make bread or cakes rise, yeast is often used. But, to make pancakes fluffy, chefs around the world use baking soda and/or baking powder depending on the ingredients called for in the recipe. Baking soda consists of a single chemical, sodium bicarbonate (or bicarbonate of soda).[13] The bi-product that both yeast and sodium bicarbonate create is carbon dioxide, or CO_2. This is the same reason baking soda will dissolve in water and bubble in acetic acid, or vinegar. Baking powder contains one or more acid salt that is added to sodium bicarbonate. These salts can include: monocalcium phosphate/monohydrate, dicalcium phosphate dihydrate, sodium aluminum sulfate, sodium aluminum phosphate, or and potassium bitartrate (street name: cream of tartar). These dry acid salts are added to the baking soda when the recipe contains no other acid ingredients. Cornstarch is also added to baking powder to reduce clumping. As soon as baking powder gets in contact with a liquid, it reacts and begins to produce the carbon dioxide gas that helps to leaven cakes, cookies, brownies, and other baked goods. Baking soda, or pure sodium bicarbonate, on the other hand, is the stuff people keep in their freezers to absorb the odors. This stuff begins to react and create carbon dioxide when it comes into contact with an acidic liquid, such as buttermilk, sour cream, applesauce, citrus juices, honey, molasses, or vinegar.[14] The chemical reaction is:

$$Na^+ + HCO_3^- + CH_3CO_2H \rightarrow H_2O + CO_2 + Na^+ + CH_3CO_2^-$$

showing that sodium bicarbonate and acetic acid react to produce water, carbon dioxide, and sodium acetate. Some recipes call for both baking soda and baking powder, or double acting baking soda, to neutralize excess acid in a recipe. In this case, the baking soda reacts to create carbon dioxide in the mixed batter and then more carbon dioxide is created in the baking process once heat is added, thus making it double acting. There isn't one recipe for baking powder; in fact, search the internet and you will find many different versions, all including sodium bicarbonate, an acid salt or mixture of a few, and sometimes corn starch if a big batch is being made for storage. If too much sodium bicarbonate is added, it causes the cell walls to stretch and break, releasing the carbon dioxide resulting in a batter that is both low in volume and coarse in texture. If too little bicarbonate is added, the pancake will not be leavened and soggy.[15]

Although not common for pancakes, yeast is used in at least one place in the world to leaven the pancake. Yeast works similarly to sodium bicarbonate in the fact that it creates carbon dioxide to leaven the batter or dough. Yeast, however, is an organism that reacts with the liquid in the recipe and feeds off the sugar added to the recipe and also the sugar in the flour. Carbon dioxide is the bi-product of this reaction. A similar reaction is used in the fermentation process to make alcohol in beer.

Other ingredients are simply added to enhance the flavor. Sugar is for sweetness. Spices are used for added flavor and complexity. Years ago cinnamon, ginger, garlic, cloves, and honey were added for preservation.[16] Butter, when added to the final product dissolves fat-soluble substances[17] and is used to bring out the flavors of the pancake and pancake topping. Salt is used in some pancake batters to bring out the flavors; however, in batter or dough that uses yeast as a leavening agent, the salt does a different job. It dehydrates yeast cells to slow down production of carbon dioxide.[18]

Heat

The application of heat to a reactant causes several chemical reactions in a batter or dough. The first is the

production of carbon dioxide gases as mentioned above. The second reaction explains the color. When heat is applied, the outside of the pancake (or other baked product) browns because of the Maillard reaction. The protein reacts with sugar due to the heat, causing the browning.[19] The Maillard reaction is responsible also for the browning of ground meat and the browning that happens when condensed milk is cooked to make *dulce de leche*. Caramelization is the browning that occurs with heat when a protein is absent such as the case in onions or sugar.[20]

Kitchen Ratios

Pancakes

The key to making the perfect pancake mixture is the ratio of flour and liquid in the batter. Batter and dough both contain some ratio of flour and liquid and are classified by this ratio. Batters, which pancakes are made of, are considered quick breads because of the fact that the batter is quick to mix and the "bread" is leavened by chemicals (sodium bicarbonate) rather than biologically with yeast, which takes longer to leaven. Batter has a ratio of 1-2 parts flour to 1 part liquid and dough has a ratio of 3-8 parts flour to 1 part liquid. The more flour in the ratio, the stiffer dough. Soft dough is used for biscuits while stiff dough is used for piecrust. According to most chefs, the ratio of flour to liquid to fat to make the perfect pancake is 2 parts flour, to 2 parts liquid, to 1 part egg, and a half part fat.[21] Of course cooking techniques also affect the end product. Cooking techniques can include how thoroughly the batter is mixed, the temperature of the batter, the temperature and material of the pan or griddle, and lastly any additives added to the pancake. Luckily, because of the higher content of liquid in the pancake ratio, you don't need to pay too much attention to over-mixing. Under-mixing the batter though, well that is another story. Adding 2 tablespoons of baking powder will make the pancake fluffier and less dense. Changing this ratio by having the liquid part equal to twice the flour part and not using fat will make a crepe.

Other Important Kitchen Ratios

Of course ratios are important in other recipes as well. How does the saying go? Measure twice and cut once. Maybe that has more to do with building a house than it does with cooking, but nevertheless it points to the importance of precision of baking. Have you ever looked at the back of a brownie mix box? The measurements are different depending on the type of brownie is preferred. Have you ever tried to make a hollandaise sauce? The process requires not only precision in the process, but in the ratio of the mixture as well.

According to Martha Stewart, a fudgy brownie has a higher fat to flour ratio while cakey brownies have more flour and use baking powder.[22] The boxed mixture calls for more eggs for the cakey brownie as well. Just like in the case of the dough and batter mixtures, higher fat content results in a chewier product. Similarly, the addition of baking soda to the recipe adds carbon dioxide, making the brownie lighter and less dense.

For mayonnaise, hollandaise sauce, béarnaise sauce, and salad dressings such as thousand island, ratios are important in order to create a stable combination of two liquids that don't ordinarily mix: oil and water. Oil's hydrophobicity property means it does not mix with water unless introduced with an amphiphilic substance such as egg or egg yolk.[23] When the proportions are done correctly, with the oil added to the recipe slowly, the oil and water-based substance (lemon juice, vinegar, etc…) become emulsified and the result is a water-in-oil emulsion. The emulsifier (the egg yolk) breaks down the oil into droplets that then surround the hydrophobic substance and making the sauce stable.

Substitutions

There are many reasons for substituting ingredients in pancakes. Substitutions are determined by local ingredients as well as dietary needs. For example cornmeal, whole-wheat flour, or other ground grains can replace the flour and change the texture and flavor of the pancake. Buttermilk or yogurt can replace the liquid to add a complexity to the flavor.[24]

Pancakes Around the World

To make Navajo blue corn pancakes, the Navajo use blue corn as the starch, goat milk as the liquid, and juniper ash as the substitute for baking soda.[25] Juniper ash also increases the nutritional value of the pancake because it is packed with calcium, which is good for healthy bones, and vitamin A, an antioxidant. Similarly, the Salvadoran Pupusa has an option for a batter made with either corn flour or wheat flour. The Columbian Arepa also uses corn flour. Filipino Bibingka uses a rice-based flour for the starch and coconut shavings mixed with sugar as the sweet topping. South Asian Dosa also uses rice but the addition of black lentils into the basis of the batter changes the flavor, making it unique to the region. Nicaraguan Manuelitas use the same ratio as the pancake, except the recipe calls for the addition of salt to the batter and uses *queso seco* (dry cheese) and sugar as a topping. The Russian Olady[26] also uses a similar ratio; however, the traditional recipe calls on yeast as the leavening agent rather than sodium bitartrate. Rosa Parks' "Featherlite Pancakes" call on two tablespoons of baking powder (for the featherlite part), sugar, and 1/3 cup of peanut butter for the batter.

Dietary Substitutions

Nut milk or (almond, coconut, cashew) soymilk can be used in recipes for people with lactose intolerance. Some dietary restrictions (or trends?) are even completely getting rid wheat flour in exchange for more complex carbohydrates or "good carbs" such as sweet potato or banana. And then of course there is the gluten-free pancake for those with a gluten intolerance or celiac disease. Wheat, barley, and rye have "gluten forming potential" while popular substitutions such as nut flours, root tuber flours (cassava, sweet potato, yam), soy, corn, and rice flours do not have protein composition needed to form the structure provided by gluten that holds the carbon dioxide.[27] Other flours have protein compositions that provide some structure to hold the carbon dioxide that gives cakes and bread their desired consistency; however, gluten is a particular protein that seems to do it best.

Teaching Strategies

Anchor Chart

An anchor chart is a visual representation of a concept, process, or other content. These charts are hung up around the classroom and referred to regularly throughout unit lessons.

Math and Science Journals

Journals are personal notebooks (usually composition or spiral bound). The journals are set up like a non-fiction textbook with a table of contents, page numbers, and an index. Pages of the journal are used for scientific drawings, observations, tables and charts, or academic writing.

Cornell Note-Taking

The Cornell Note[28] taking is a common note taking strategy that can be used in any lecture, video, discussion, or reading. Students take notes on the right side of the page and write questions on the left side, highlighting content vocabulary and underlining any important information. Students then write a summary of the notes by succinctly answering the questions from the left side. This type of note taking strategy allows for students to interact with their notes on multiple occasions. During the first go around, the students take notes. Next, students highlight important concepts and write questions on the left margin. Finally, a summary is written about the content of the notes. This strategy helps students to store the information given into their long-term memory through the multiple reviewing of the notes. Pages in the scientific journal can be set up for Cornell Note-Taking.

Examination of Primary Sources

Students look closely at primary sources: first-hand accounts, written journals, photographs, etc. in order to get information.

Structured Student Talk: Whip Around

A Whip Around is one structured student talk activity aimed to achieve equity of voice in a class discussion. Students are presented with a question, usually one that everyone has a response to, and students take turns sharing their response to the question.

Tape Diagrams/Bar Diagrams

Tape diagrams, also known as horizontal bar diagrams, are used to model equivalent ratios using fractional-sized rectangles. This teaching strategy has been used successfully in Japan and Singapore for many years bridging the pictorial or concrete representation of quantitative data and abstract representation with a tape diagram.[29]

Ratio Tables

Ratio tables are used to list equivalent ratios in ascending order with the smallest unit at the top under the heading of items being compared.

Double Number Lines

A double number line is a set of two parallel lines representing two quantities in a ratio being compared. Starting with zero, students choose an appropriate scale for each number line depending on the numbers in the ratio being compared. This works similarly to a ratio table but students are also able to expand the number line to see quantities in between equivalent, whole number, ratios.

Silent Line-Up

In the silent line-up[30] activity, students work together to silently place themselves in order according to criteria given to them by their teacher. This is typically done by birthday, but it could also be done to create any sort of agree/disagree spectrum and be used as a tool to create partners or groups by folding the line in half or counting off to create larger groups.

Sentence Frames

Sentence frames are used in order to develop fluency in academic speaking and writing. These frames can be categorized by their language function (cause and effect, sequencing, claim and evidence, explain and describe, or proposition and support).[31] These sentence frames include academic content vocabulary (or brick words) and the words that go along with the academic content vocabulary needed for sense making and fluidity (mortar words).

Experiential Learning

Cooking is a way to bridge the concepts or ratios, the Common Core Mathematical Practice of attending to precision, science content, and high student engagement. Culturally relevant connections can be made with students' home cultures in a hands-on way.

Socratic Seminar/Paideia Seminar

Students discuss which recipe makes a "just right" pancake in a Socratic Seminar. For this, students' desks need to be arranged so they are facing each other and use their Cornell Notes for this discussion. Follow the protocols detailed in Chowning's research study, "Socratic Seminars in Science Class".[32]

Classroom Activities

Lesson 1 – Pancakes Around the World

Every culture in the world has some form of a pancake as a dish. Students will have experience with this especially if you show a picture of a pancake and give an example of a pancake from another culture. Brainstorm types of pancakes your students have eaten at home using a "Whip Around" and record the results on an anchor chart. For homework, ask students to bring in a "pancake" recipe that is used at home or ask them to search the internet for one from their culture.

Lesson 2 – Examine Primary Sources

Compare the recipes students bring in and talk about the ingredients. Examine Rosa Parks' recipe.[33] Ask students what all recipes have in common (flour, liquid, egg, fat, additive, extras). Make an anchor chart recording the measurements starting with Rosa Parks'. See Figure 1 for the anchor chart set up.

Figure 1: Anchor chart for discussion about pancake recipes in Lesson 2.

Recipe	Flour	Liquid	Egg	Fat	Additive	Extras
Rosa Parks' Featherlite	1 c	1 ¼ c milk	1 egg	1 T oil	2 T baking powder	½ t salt, 2 T sugar, 1/3 c peanut butter

Lesson 3 - Cornell Note-Taking on Different Representations of Ratios

Ratios can be expressed in many ways. The most common way is through the use of the colon (2:1). Students take notes in their journals, highlight key vocabulary, and add the vocabulary to the index.

Lesson 4 – Representing Equivalent Ratios Using Tape Diagrams

Eureka Math Grade 6 Module 1 Lesson 1[34]

Lesson 5 – Tape Diagrams with Recipe Ratios

Students examine the anchor chart from lesson 2 and chose pancakes to write ratios for. Students then complete tape diagrams for each ratio. See Figure 2.

Figure 2: Worksheet for Lesson 5

Name_____

Date_____

Period____

Pancakes!

Directions: Write the ratio. Draw a tape diagram.

Recipe: _____ **Ratio: _____ : _____** **What are you comparing?** **_____ to _____** **Tape Diagram:**	**Recipe: _____** **Ratio: _____ : _____** **What are you comparing?** **_____ to _____** **Tape Diagram:**
Recipe: _____ **Ratio: _____ : _____** **What are you comparing?** **_____ to _____** **Tape Diagram:**	**Recipe: _____** **Ratio: _____ : _____** **What are you comparing?** **_____ to _____** **Tape Diagram:**

Lesson 6 – Students write Multiple Ratios in Context

Eureka Math Grade 6 Module 1 Lesson 2[35]

Lesson 7– Reexamine Recipe Ratios (similar to what students did in the previous day's lesson, except this time with classroom data). See Materials for Classroom Use Figure 3.

Figure 3: Worksheet for Lesson 7

Name_____

Date_____

Period_____

Ratios in Pancakes Around the World

Pancake	Description of Ratio Relationship (Underline or highlight the words or phrases that indicate the description is a ratio.)	Ratio
Example: Rosa Parks' Feathelite Pancakes	For every 4 cups of flour, there should be 5 cups of milk. The ratio of flour to milk is 4 to 5.	4:5

Lesson 8 – Cornell Note Taking on Ingredients

Students listen and take notes about the different reactants that make pancakes: liquid, flour, egg, fat, and additives.

Lesson 9 – Demo: Sodium Bicarbonate and Acid Interaction[36]

Ingredients: 1 teaspoon baking soda, 4 tablespoons vinegar, 1 liter soda bottle (empty), and one balloon

Carefully measure the ingredients into the soda bottle, and then gently stretch the balloon over the opening. The result is water, carbon dioxide, and sodium acetate. The chemical formula is:

$Na^+ + HCO_3^- + CH_3CO_2H \rightarrow H_2O + CO_2 + Na^+ + CH_3CO_2^-$

Students do a scientific drawing of their observations of the reaction.

Lesson 10 – States of Matter Review

Students examine the ingredients in a pancake recipe, and sort them according to state of matter. What state are the incorporated ingredients before and after mixing? After heat is applied to the ingredients?

Lesson 11 – Ratio Tables

Eureka Math Grade 6 Module 1 Lesson[37]

Lesson 12 – Ratio Change

Eureka Math Grade 6 Module 1 Lesson 6[38]

Lesson 13 – Double Number Lines

Eureka Math Grade 6 Module 1 Lesson[39]

Lesson 14 – Math Assessment Project (MAPS) Formative Assessment Lesson (FAL)[40]

Lesson 15 – Nana’s Chocolate Milk[41]

This is a “Three-Act Task” that uses a video to examine the ratio of milk to chocolate powder to make chocolate milk. In the task, the main character “messes up” the ratio and the job of the class is to either add more milk or chocolate powder to the glass to get the right proportions. Students record their thinking in their journals.

Lesson 16 – Quiz

See Figure 4.

Figure 4: Ratios Quiz for Lesson 16

Name: _____ Date_____

Ratios Quiz
Using Ratio Tables, Double Number Lines and Graphs to Solve Problems

Which juice is more appley?

Room A: 1 cups apple concentrate to 3 cups water

Room B: 5 cups apple concentrate to 12 cups water

Room C: 3 cups apple concentrate to 8 cups water

1) Complete and label a ratio table for each advisory to help you answer the questions below:
(Label each table with ratio units)

Room A	

Room B	

Room C	

2) Which recipe should students use to have the **highest** concentration of apple concentrate?

_____

Prove it!

3) Which recipe should students use to have the **lowest** concentration of apple concentrate?

_____

Prove it!

Babysitting

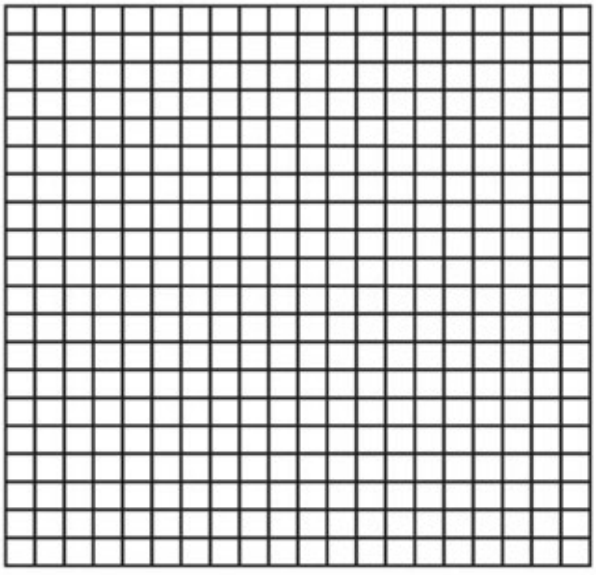
4) Over the summer, a student worked as a babysitter. For every 5 hours she worked she earned $55.

Hour	Dollars
1	
3	
5	55
	66

5) Which equation would correctly represent the relationship between the number of bikes built (b) and the amount of dollars paid (d)?

a) h= 5d
b) d=11h
c) d=11 / h
d) h=5 / d

6) Graph the relationship for hours worked to dollars paid.



Lesson 17 – Chef Guest Speaker – Guest speaker answers the essential questions: How do you use math and science as part of your job? Students take Cornell Notes.

Lesson 18 – Line Up and Pre-Work for Cooking Activity – Watch video: *Math in the Kitchen: Do you Measure Up?*[42] Have students line up in a single file line according to how they prefer their pancakes crepes on one side all the way to the fluffiest pancake on the other side of the room. Split up the class into thirds: crepes, something in between crepes and pancakes, fluffy pancakes. Have students get into pairs in their groups to discuss the ratios and ingredients. See Figure 5.

Figure 5: Worksheet for Lesson 18

JUUUST Right Pancakes

Ratio: (include unit)

_____ : _____ : _____ : _____
fat egg flour liquid

Additive: (circle one)

BAKING SODA BAKING POWDER NONE

Reflection:

JUUUST Right Pancakes

Ratio: (include unit)

_____ : _____ : _____ : _____
fat egg flour liquid

Additive: (circle one)

BAKING SODA BAKING POWDER NONE

Reflection:

JUUUST Right Pancakes

Ratio: (include unit)

_____ : _____ : _____ : _____
fat egg flour liquid

Additive: (circle one)

BAKING SODA BAKING POWDER NONE

Reflection:

JUUUST Right Pancakes

Ratio: (include unit)

_____ : _____ : _____ : _____
fat egg flour liquid

Additive: (circle one)

BAKING SODA BAKING POWDER NONE

Reflection:

Figure 6: Lesson Plan for Lesson 21

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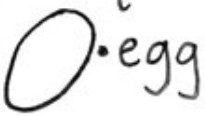
Pancakes around the world

BASIC INGREDIENTS

PANCAKES

- flour

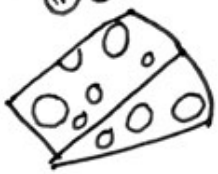
- liquid



- egg
- oil &
- baking powder

TOPPINGS

- syrup
- fruit
- sugar
- cheese



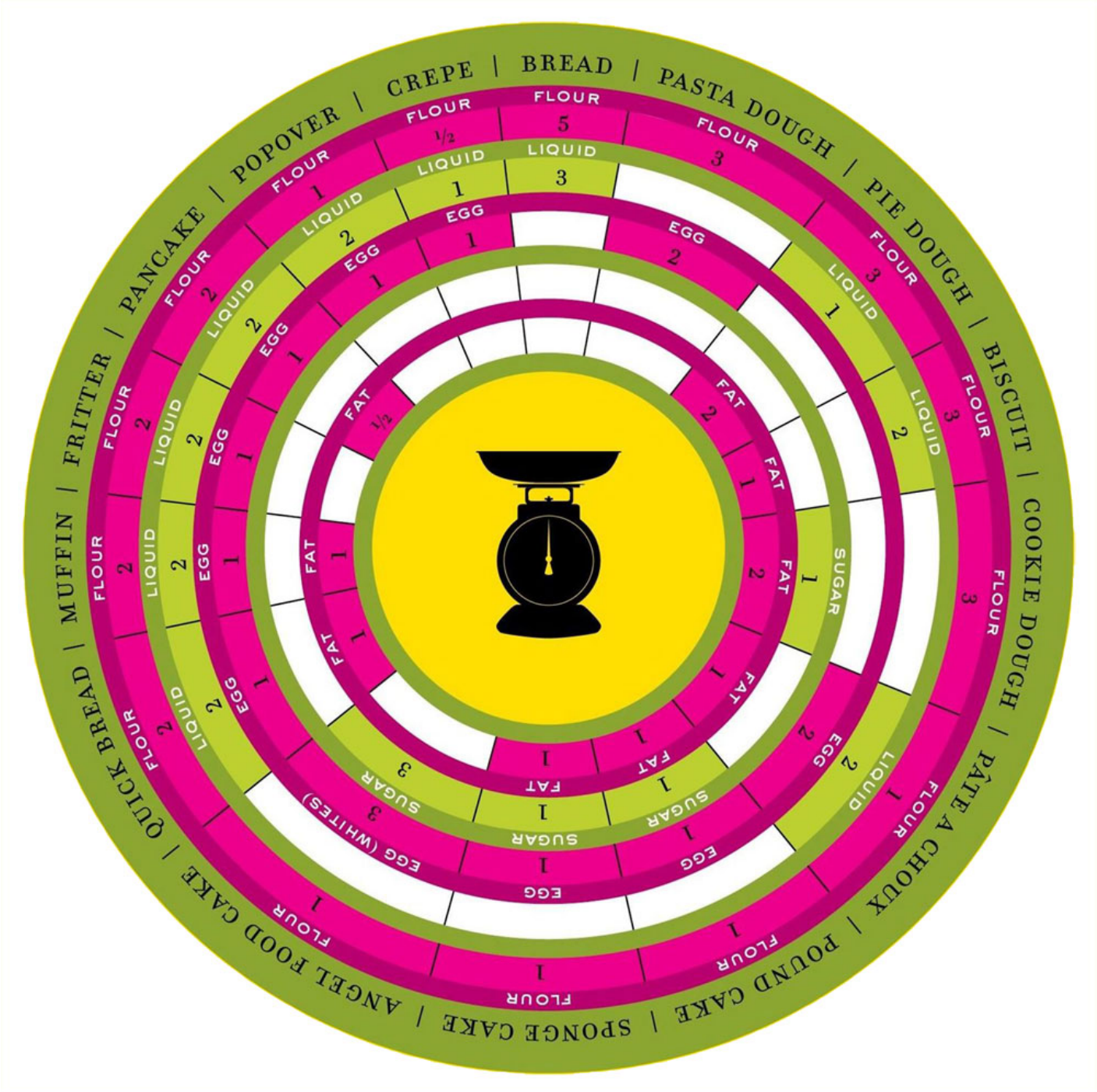
DIRECTIONS

1. Combine pancake ingredients in a mixing bowl.
2. Stir until all ingredients are incorporated.
3. Lightly coat a pan with oil and place on medium-high heat.
4. Pour batter in pan to desired size.
5. Flip when desired Maillard browning has been reached on one side.
6. Remove and plate finished pancake when desired Maillard browning has been reached on both sides.
7. Repeat until batter is gone.
8. Add desired toppings. Enjoy!

Lesson 20 – Kitchen Ratios Reflection and Recipe Redesign

Show the image Chef Hestnar's ratios (Figure 7) as discussed in Michael Ruhlman's book. Have students compare the ratios they came up with from lessons 18 and 19.

Figure 7: Chef Uwe Hestner's Ratios as described in Michael Ruhlman's book *Ratio: The Simple Codes Behind the Craft of Everyday Cooking* (Used with permission).



Lesson 21 – Kitchen Visit 2

Students retry the recipes based on their adjustments.

Lesson 22 – Socratic Seminar

Students ponder the question: What makes a perfect pancake?

Resources

Bibliography for Teachers

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Appendix: Implementing District Standards

California Common Core State Standards for Math (CA CCSS)[43]

Ratios and Proportional Relationships

Understand ratio concepts and use ratio reasoning to solve problems.

6RP1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

6RP2. Understand the concept of a unit rate.

6RP3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

a. Make tables of equivalent ratios relating quantities with whole number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.
b. Solve unit rate problems including those involving unit pricing and constant speed.
c. Find a percent of a quantity as a rate per 100; solve problems involving finding the whole, given a part and the percent.
d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

Mathematical Practices[44]

1. Make sense of problems and persevere in solving them.

Students solve real world equivalent ratio problems involving recipes.

2. Construct viable arguments and critique the reasoning of others.

Students analyze the given ratios and are able to explain the proportions in a given recipe.

3. Model with mathematics.

Students use tape diagrams, ratio tables, and double number lines to model the equivalent ratios needed to scale up or scale down a recipe.

4. Use appropriate tools strategically.

Students use measuring tools such as a digital scale, measuring cups, and measuring spoons.

5. Attend to precision.

Students calculate ratios and measure ingredients with precision in order to get a “just right” pancake.

6. Look for and make use of structure.

Students analyze ratios from given recipes to look for patterns.

Next Generation Science Standards (NGSS)[45]

Disciplinary Core Ideas

Structure, Function, and Information Processing

MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Science and Engineering Practices

MS-LS1-2 Develop and use a model to describe phenomena.

MS-LS1-1 Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.

MS-PS3-3 A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.

Crosscutting Concepts

MS-LS1-8 Cause and effect relationships may be used to predict phenomena in natural systems.

Endnotes

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