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

Mixing It Up!

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Introduction

I teach 3 rd grade at Wexler-Grant Community School in New Haven, Connecticut. We are a school that begins with headstart and ends with 8 th grade. We have an interesting history. We were two separate schools at one time: Helene W. Grant School and Isadore Wexler School. We merged during the 2002-2003 school year. Our population of students is approximately 90% African-American and the remaining 10% is made up of White, Hispanic, and Indian. We are a community school which means that our building is open to the neighborhood in a variety of ways. Meetings, seminars, conferences, and workshops take place in our building for various organizations throughout the community. Our family resource room provides services for parents, grandparents, and students. We try to truly embrace and embody the concept of community.

Rationale

Science is, and always has been, one of my favorite subjects. It also happens to be my students' favorite subject. Every class I have taught, most, if not all of my students, love science. They love the experiments and love that science generally tends to be very hands-on. In 3 rd grade the two major science kits that are done are chemical tests, and plant growth and development. STC® (Science and Technology for Children) kits are the staple of science for the elementary school in New Haven. However, some kits require a lot of time to set materials up and also to put them away. For this reason, science can be difficult to squeeze into the elementary schedule. Literacy takes up most of our time. We have to squeeze in Mathematics and try to incorporate Social Studies. Science is often neglected and/or not given the proper time that is needed to truly teach all of the many aspects that incorporate science. Many of our kids think that science is just doing "cool experiments." They don't understand why or the procedures that scientists use to lead up to the actual experiment as well as what scientists do after the experiment is complete. Teachers have a lot of work to do to make science more integral. This unit, I believe, will be a step in the right direction.

This unit will integrate something that most kids love...food. We will use food to learn about how science works and that cooking uses many of the science principles. In the past I have used making KOOL-AID® as a way to teach about solutions. I would like to expand upon those lessons and teach about other types of mixtures. The unit will give an overview of basic chemical principles so that chemistry terminology can be used without confusion or uncertainty. Water will be an integral part of this unit. It is the most common molecule used in cooking. We all know that we need water to survive, but there are many scientific aspects of water that the average person and student may not know. The unit will then progress on to solutions, gels, foams, suspensions, and emulsions. Throughout the unit, the words KOOL-AID® and JELL-O® are used. These are used as generic terms. Any powdered soft drink or gelatin can be used.

The primary source used for this unit is Harold McGee's wonderful book: On Food and Cooking-The Science and Lore of the Kitchen. McGee writes in a style that is easy to understand and does an excellent job of scientifically explaining what is happening during the preparation of food and the cooking process. He makes an excellent connection with science principles and the art of cooking. McGee is able to explain the science behind the biological and chemical changes in food from boiling water to making a souffl¨é.

The goal of this unit is to help students understand that there are various types of mixtures. They will also need to know the criteria that define the mixture. After doing the various experiments, they should be able to use a rubric and determine if something is a solution or a suspension, a gel or foam. A secondary goal of this unit is to help students follow a sequential order. There are directions that they are going to have to follow in a recipe and understand that sometimes things must be done in a sequential way to get the desired result.

Basic Chemical Principles

All matter on earth is made up of a mixture of about 100 pure substances which are called the elements. [1] Atoms are the smallest particle into which an element can be subdivided without losing its characteristic properties. [2] The ancient Greeks gave us the idea and the word atoms. To them it meant fundamentally and invisibly small particles of matter. The ancient Greeks also believed that an atom was "uncuttable" or "indivisible". [3] Atoms are extremely small. So small in fact that about 100 trillion would fit into the period at the end of this sentence. [4] The subatomic particles of an atom are called electrons, protons, and neutrons. The different properties of the elements arise from the varying combinations of subatomic particles that make up their atoms. [5] When two or more atoms bond together, they do so by sharing electrons with one another. When atoms bond, they form a molecule. The molecule relates to a chemical compound the way an atom relates to an element. Most matter on earth, including food, is a mixture of different chemical compounds. [6] The electrical attractions between protons and electrons are the most important driving force behind all of the chemical activity that makes life and cooking possible. Protons carry a positive electrical charge and electrons carry an exactly balancing negative charge. Neutrons are neutral and they carry no charge. Opposite electrical charges attract one another, while similar electrical charges repel one another. The electrons in atoms are arranged around the nucleus in orbits that determine how strongly any particular electron is held there. [7] The closer an electron orbits the nucleus the stronger the bond. The farther away an electron orbits the nucleus, the weaker the bond.

One of the most important elements that readily grabs electrons is oxygen. It is done so much that scientists have given it a name called oxidation. Oxidation is the general chemical activity of grabbing electrons from other atoms. Oxidation can still happen even if oxygen is not involved. With oxygen always present in the air, it is very important in the kitchen. Oxygen eagerly steals the electrons from the carbon-hydrogen chains of fats, oils and aroma molecules. The preliminary oxidation triggers a cascade of further oxidations and other reactions that end up breaking the original large fat molecules into small, strong smelling fragments. This is can be an indication that something has gone bad. Antioxidant substances can prevent this breakdown by giving oxygen the electrons that it wants without starting a cascading reaction.

An interaction between atoms or molecules that holds them together, either loosely or tightly, momentarily or indefinitely is called a chemical bond. This is important because there are several types of chemical bonds that are in nature as well as in the kitchen.

The ionic bond is one kind of chemical bond in which one atom completely captures the electron(s) of another atom. Chemical compounds which are held together by ionic bonds readily dissolve in water. However, to do so they must come apart into separate ions, which are atoms that are electrically charged because they either carry extra electrons or gave up some of their electrons. One of the most common seasonings, salt, is a compound of sodium and chlorine held together by ionic bonds. Pure salt as a solid crystal is positively charged sodium ions alternate with negatively charged chloride ions. The sodiums in salt have lost their electrons to the chlorines. When salt is dissolved in water, it separates into positive sodium ions and negative chloride ions.

A second type of chemical bond is called a covalent bond. A covalent bond produces stable molecules. When two atoms have roughly similar affinities for electrons, they will share them rather than gain or lose them entirely. [8] The elements most important to life on earth: hydrogen, oxygen, carbon, nitrogen, phosphorus, and sulfur, all tend to form covalent bonds. [9] These bonds make possible the very complex, stable assemblages that make up our bodies and our food. Water, probably the most well known pure chemical compound in the kitchen, is made up of two hydrogen atoms and one oxygen atom. Another well known chemical compound found in the kitchen is sucrose, or table sugar. Sugar has a combination of carbon, oxygen, and hydrogen atoms. Covalent bonds are typically very strong and stable at room temperature. They are usually not broken in significant numbers unless subjected to heat or reactive chemicals. Covalent bonds are different from ionic bonds (salt) because when they dissolve in water, they remain intact as electrically neutral molecules.

A third type of chemical bond is the hydrogen bond. A hydrogen bond is about a tenth as strong and stable as covalent bonds. There are several "weak" bonds and the hydrogen bond is one of them. These "weak" bonds do not form molecules, but they do make temporary links between different molecules, or between different parts of one large molecule. A hydrogen bond is very important because it is very common in materials that contain water. Thus it brings different kinds of molecules into close association, and because it is weak enough, these molecular associations can change rapidly at room temperature. Many of the chemical interactions in plant and animal cells occur via hydrogen bonds. [10]

A fourth type of chemical bond is the van der Waals bond. This is a very weak bond and is between a hundredth and a ten thousandth as strong as a covalent bond. Thanks to brief fluctuations in their structures, van der Waals bonds have flickering attractions that even nonpolar molecules can feel for each other. Nonpolar fat molecules are held together as a liquid and given its thick consistency by van der Waals bonds. Van der Waals bonds are very weak, but their effect can add up to a significant force. This is achieved because fat molecules are long chains and they include dozens of carbon atoms. Thus, each fat molecule can interact with many more other molecules than a small water molecule can.

The Phases of Matter

Matter occurs in three different states. These different states are known as the solid phase, liquid phase, and gas phase. The temperatures at which a substance melts and changes from a solid to a liquid, and the temperature at which a liquid boils and changes from a liquid to a gas, are all determined by the bonding forces among atoms and or molecules. The stronger the bonds, the more energy is needed to overcome those bonds. Thus, the higher the temperature at which the material shifts from one phase to another. During the shift from one phase to the next, all the heat added to the material goes into completing the phase change. While heating a solid-liquid mix the temperature of that solid-liquid mix (i.e. ice water) will remain fairly constant until the entire solid has melted. Likewise, water (liquid) that is boiling, remains at that constant temperature but after it turns to steam (gas) the temperature of the steam can rise dramatically.

Solids

Atomic motion is limited to rotation and vibration at low temperatures. The immobilized atoms or molecules bond tightly to each other in solid, closely packed, well-defined structures. [11] These structures make up the solid phase.

Liquids

The rotation and vibration of individual molecules in a substance becomes forceful enough that the forces holding them in place are overpowered. The fixed structure then breaks up, leaving the molecules free to move from one place to another. However, most of the molecules are still moving slowly enough that they remain influenced by the forces that once immobilized them, so they remain free to move, but they move together. This fluid but cohesive phase is called a liquid. [12]

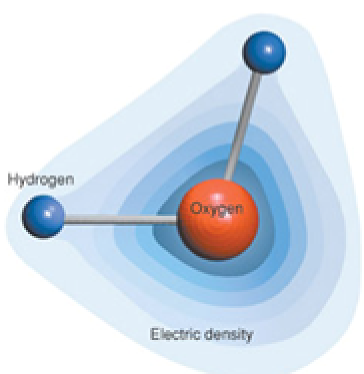
Gases

If the temperature of a substance continues to rise and the molecules move with kinetic energy high enough that they can break away from each other's influence completely and move freely into the air, this substance becomes a different kind of fluid called a gas. [13]

Water

Water is the most influential element of nearly all foods. It is also used in a way in which food can be heated so that it can change the flavor, texture, and stability. One particular property of water solutions, their acidity or alkalinity, is a source of flavor, and has an important influence on the behavior of other food molecules. [14] Water is the most familiar chemical known. It is the smallest and simplest of all of the basic food molecules. It has just three atoms, two hydrogen and one oxygen. Water is probably the most important element on the planet. All life on the planet, including our own lives exists in a water solution. The human body is made up of about 60% water by weight, raw meat is about 75% water and fruits and vegetables are anywhere up to 95% water. [15]

Each water molecule is polar, which means it is electrically asymmetric. A water molecule has a positive end and a negative end. This happens because the oxygen atom exerts a stronger pull than the hydrogen atoms on the electrons they share. As a result, because the hydrogen atoms project from one side of the oxygen, it forms a V shape. The water molecule now has an oxygen end and a hydrogen end. The oxygen end is more negative than the hydrogen end. This polarity means that the negative oxygen on one water molecule feels an electrical attraction to the positive hydrogens on other water molecules. [16] This attraction brings the two molecules closer to each other and holds them there. This is called a hydrogen bond. The molecules in ice and liquid water are participating in from one to four hydrogen bonds at any given moment. [17] The hydrogen bonds in liquid water are transitory, they are constantly being broken and reformed. This happens because the motion of the molecules in liquid is forceful enough to overcome the strength of the hydrogen bonds.



Here is a diagram of a water molecule courtesy of the Lawerence Livermore National Laboratory website: https://www.llnl.gov/str/October05/Mundy.html. It does a nice job of showing the bond between the positively charged hydrogen and the negatively charged oxygen.

McGhee has a small section in his book entitled: Water Is Good At Dissolving Other Substances. This is essential to the theme of this unit. The general person usually thinks of water if something needs to be dissolved. Let's look at why water is good at dissolving other substances. Water forms hydrogen bonds not only with itself, but with other substances that have at least some electrical polarity, some unevenness in the distribution of positive and negative electrical charges. [18] Out of all of the major food molecules, carbohydrates and proteins, which are much larger and much more complex than water, have polar regions. This is significant because water is attracted to these polar regions and they cluster around them. By doing this, the water surrounds the larger molecules and separates them from each other. When each of the larger molecules is mostly surrounded by water molecules, then that substance is considered to dissolved. This is important for small molecules like sugar and salt. This is a crucial concept for students to understand in this unit. This will be a critical element in the upcoming lessons. As they are making KOOL-AID® for solutions and JELL-O® for gels this is a vital step in the process. This will also be essential during one lesson when they are comparing whether the liquid they see is a solution or if it is a suspension.

The hydrogen bonds in water have a strong effect on how water absorbs and transmits heat. Water exists as a solid at low temperatures 32 $^{\circ}$F and below, a liquid at temperatures of 33 $^{\circ}$F to 211 $^{\circ}$F, and a gas at a high temperatures of 212 $^{\circ}$F and higher. The hydrogen bonding between the molecules has an effect on all three phases. Water as a solid is commonly referred to as ice. Ice happens when the attraction of the molecules for each other becomes stronger than their movements. The molecules settle into a compact arrangement determined by their geometry. [19] As a result, ice is a solid that has more space between molecules than the liquid phase thus, it expands. When raw plants or meats are frozen, the tissues are damaged and this causes liquids to leak when they are thawed. While the raw vegetables or meat is freezing, the expanding ice crystals rupture the cell membranes. Thus, when those vegetables or meat begins to thaw, they lose their internal fluids.

As stated earlier, the hydrogen bonds in water play an important role in the three phases of water. The hydrogen bonds in water cause water to have a high specific heat. Specific heat is the amount of energy that is needed to raise the temperature by a given amount. What this means is that water has to absorb a lot of energy before its temperature rises. Thus, liquid water is slow to heat up. It takes 10 times the energy to heat an ounce of water 1 $^{\circ}$ as it does to heat an ounce of iron 1 $^{\circ}$. [20] As a result, a pan on the stove with nothing in it will get hotter much quicker than water that may also be in a pan on the same stove with the same heat. The reason why water heats slower than metal is that before the heat energy added to the water can cause molecules to move faster and its temperature to rise, some of the energy must first break the hydrogen bonds so that the molecules can move faster. This is the boiling that can be seen when water is heated. This also allows the water to hold a higher temperature for a longer period of time.

As water vaporizes and turns into steam, it absorbs a lot of heat. The hydrogen bonding gives water an unusually high latent heat of vaporization. [21] This means that the amount of energy that water absorbs without a rise in temperature as it changes from a liquid to a gas. This is important to people because this is the process that helps us from overheating. Sweating uses this principle by using the water that has collected on our overheated bodies. The water on the skin collects and absorbs energy/heat and carries it away into the air. This process has been used even in ancient cultures. Porous clay pots were used to keep water or wine cool. The porous clay pots would evaporate moisture continuously and keep its contents cool. Cooks also use evaporation in cooking foods like custards when they partially immerse the containers in open water. Oven-roasted meats cooked slowly also use this process. Evaporation allows the food to release energy or it removes energy from the surrounding area and this causes the food to cook more gently.

When steam condenses into water, it releases a lot of energy. When steam hits a cool surface and condenses into liquid water, it gives that same high heat of vaporization. [22] As a result of this, steam is a very effective and quick way to cook food. Steam at 100 $^{\circ}$C/212 $^{\circ}$F is very different than air at the same temperature which is also a gas. This explains why it is much easier to tolerate the heat in an oven for a much longer time than being exposed to steam at the same temperature. Steam will scald or burn skin within seconds as opposed to air which will take a much longer time to achieve the same effect. This is why it is very important to take safety precautions when working with steam. It can be much hotter than boiling water and can burn within seconds.

Solutions

A solution is a material in which individual ions or molecules are dispersed in a liquid. [23] It can also be defined as a homogenous mixture of two or more substances. [24] In simpler terms, this is when one element dissolves into another element, usually into a liquid like water. The substance that is dissolving is called the solute. The liquid that the solute is dissolving into is called the solvent. What is happening on a molecular level is the solute, such as sugar or salt, that are dissolving into the solvent (water), take up the extra space between the water molecules. A solution becomes saturated when no more solute can dissolve into a solvent. If you have ever made KOOL-AID® and added extra sugar, the sugar that is lying at the bottom of the pitcher is an example of the water being saturated with sugar. No matter how much it is stirred, it seems that the sugar just spins around. Ways of allowing a solvent to exceed its saturation point is to change the environmental factors such as temperature or pressure. Often times by raising the temperature of the solvent, this allows it to dissolve more solute. Solutions are usually clear because the solute molecules are so small, light rays pass through them.

Solutions can exist in all three phases of matter. As a gas, the air we breathe is an example of a solution as it is made up of nitrogen, oxygen and other gas molecules. As a solid, steel and bronze are examples of a solution as they are a combination of iron, copper, carbon, and other elements. As a liquid, ethanol is an example of a solution. Ethanol in water creates your typical alcoholic beverages. Examples of solutions in food are salt water, sugar water, and sugar syrups as well as soda pop which is a mixture of water, carbon dioxide and sugar.

Gels

McGhee defines gels as a dispersion of water in a solid: the molecules of the solid form a sponge-like network, and the pockets of water are trapped in the network. [25] The interesting thing about gels is that they are mostly liquid, but they behave like solids due to the sponge-like network which is three-dimensional. The network is what gives the gel its structure or stiffness as well as contributing to its stickiness. The properties of gels can range from soft and weak to hard and tough. Examples of gels in foods are jellies made with gelatin or pectin and JELL-O® gelatin.

Foams

A foam is a dispersion of gas bubbles in a liquid or solid. [26] Another way to define a foam is a substance that is formed by trapping many gas bubbles in a liquid or solid. [27] There are typically so many bubbles that it is impossible to distinguish separate bubbles with the naked eye. Foams are typically disorganized with a wide variety of bubble sizes. Foam has many practical applications as insulation, packing material, cleansers for body and dish, and as a fire retardant. Examples of foam in food are whipped cream, souffl¨és, bread, and the foam at the top of a glass if you pour warm soda into it.

Suspensions

A suspension is a material in which a substance is dispersed in a liquid in clusters or particles consisting of many molecules. [28] Another definition is a heterogeneous fluid containing solid particles that are sufficiently large for sedimentation. [29] Over the course of time larger particles tend to separate from the liquid due to gravity or some other laboratory technique to speed up and simulate the force of gravity. Particles are typically large enough to deflect light rays or absorb them. As a result, a suspension is usually cloudy. This is one key difference between a solution and a suspension, a solution is usually clear as stated earlier. The texture of a suspension depends on the size and concentration of the particles that are mixed in the liquid. When food is thickened with suspensions, microscopic chunks of plant or animal tissue are suspended in the liquid. This gives the impression that the liquid is thick because the plant and animal particles interfere with the liquid's flow. Muddy water and paint are examples of suspensions. Examples of suspensions in food are non-fat milk and Milk of Magnesia which is not food, but it is taken orally.

Emulsions

An emulsion is a special kind of suspension, one in which the dispersed substance is a liquid that can't mix evenly with the containing liquid. [30] In lay terms, this means mixing two or more liquids that under normal circumstances are unblendable. They are liquids that don't like to be with one another as well as dissolve in each other. If two liquids are being emulsified, one could be called the container and the other the contained. [31] The liquid that is being contained or dispersed, is broken up into smaller droplets. The smaller droplets are then contained within and surrounded by the other liquid. The dispersed liquid takes the form of tiny droplets that are between a ten-thousandth and a tenth of a millimeter across. [32] The droplets are large enough to prevent light from traveling through the surrounding liquid. The light is either deflected or absorbed, thus giving emulsions a milky appearance.

If two liquids like oil and water are mixed together, after a period of time they will separate into two distinct layers. It takes a lot of effort to make an emulsion. The two different liquids will spontaneously arrange themselves in a way that minimizes their contact with each other. This tendency of liquids to minimize their surface area is an expression of the force called surface tension. [33] It takes a lot of energy through shaking, stirring or homogenizing (a process that reduces another liquid into extremely tiny droplets) to overcome the surface tension. This generally produces an unstable emulsion. Over time the two liquids will separate. To create an emulsion that lasts over an extended period of time a surfactant or emulsifier is needed. A surfactant or emulsifier both work to do the same thing. They lower the surface tension of one liquid so that it is easier to mix the two liquids. The surfactant/emulsifier works as an intermediary between the two incompatible liquids. Thus the surfactant/emulsifier is able to partly dissolve in each of the two competing liquids. The surfactant/emulsifier is partially hydrophobic, it has the fear of water, and partially hydrophilic, it does not have the fear of water. [34]

Examples of emulsions are the photo-sensitive side of photographic film, magma, and cutting fluid for metal working. [35] There are many examples of emulsions in food. Vinaigrette salad dressing, mayonnaise, and hollandaise sauce are some examples of emulsions. Emulsions that occur naturally in nature are milk, cream, and egg yolks.

Lesson 1

Let's Find A Solution!

Objective: Students will be able to create a solution using powdered KOOL-AID®, sugar and water and recognize the principles that determine a solution.

Students will be able to define what dissolve means through experience of mixing water and sugar and powdered KOOL-AID® and reading.

Students will be able to read and follow directions to completion to make KOOL-AID®.

Materials: 6-10 1 liter pitchers, 6-10 large spoons, KOOL-AID® unsweetened or unsweetened, 5lb bag of sugar, measuring cup, food coloring, clear plastic cups, flashlight, plastic wrap or aluminum foil

Procedure: Students working in groups of four will initially use food coloring and water to make a solution. Students will make observations and write what they think the criteria of a solution are on chart paper. Their observations will be compared to the actual standards of a solution. Students will use the flashlight to see if light passes through the solution. Students will then make KOOL-AID® and observe if it follows the standards of a solution.

Other experiments to do with this lesson:

Make the unsweetened KOOL-AID® without any sugar. What does it taste like?

Lesson 2

Who Would Like Some JELL-O®?

Objective: Students will be able create a gel using JELL-O® gelatin and understand the principles that determine a gel.

Students will be able to define what dissolve means through experience and reading.

Students will be able to read and follow directions to completion (with adult assistance) to make JELL-O® gelatin.

Materials: 6-10 mixing bowls, 6-10 large spoons, JELL-O® gelatin, large pot for boiling water, stove top or hot plate, measuring cup, clear plastic cups, masking tape

Procedure: Students working in groups of four will make observations and write what they think the criteria of a gel are on chart paper. Their observations will be compared to the actual standards of a gel. Students will then make JELL-O® gelatin and observe if it follows the standards of a gel. Students will pour the JELL-O® gelatin mix into their plastic cup. The will have already placed the masking tape on their cup, on which they will write their name. Students will make written observations about their JELL-O® gelatin before it is refrigerated. They will determine how it is different or the same from the KOOL-AID® they made previously. The students will cover their cups with plastic or aluminum foil and place them into the refrigerator to chill overnight. The next day, the students will compare how their JELL-O® gelatin has changed. Students will talk about characteristics of liquids versus solids.

Other experiments to do with this lesson:

Make the JELL-O® gelatin again but don't boil the water. The JELL-O® gelatin should remain a liquid. The boiling hot water is an integral part of the gelatin making process. Students can make predictions about what they think will happen.

Make the JELL-O® gelatin again but only use boiling water. This should in effect make JELL-O® JIGGLERS®. Again, students can make predictions about what they think will happen. Students can then compare the properties of regular JELL-O® gelatin and JELL-O® JIGGLERS®

Lesson 3

Foam, Foam Everywhere!

Objective: Students will be able create a foam (whipped cream) using heavy whipping cream and understand the principles that determine a foam.

Students will be able to read and follow directions to completion (with adult assistance) to make foam (whipped cream).

Materials: 6-10 mixing bowls (preferably metal), 6-10 whisks, heavy cream or whipping cream, powdered sugar, measuring cup, clear plastic cups, ice (optional for ice bath)

Procedure: Students working in groups of four will make observations and write what they think the criteria of foam are on chart paper. Their observations will be compared to the actual standards of foam. Students will then follow the directions to make whipped cream by hand using the whisk and a frozen metal bowl and observe if it follows the standards of foam. After successfully making whipped cream, students will use the whipped cream as topping for the JELL-O® they made previously. Students will talk about characteristics of liquids versus solids.

Something to beware of: The metal bowls should be placed in the freezer at least one hour before attempting this. Ideally, while whipping up the whipped cream, it is easier if the metal bowl is sitting in ice. This may be difficult to do with a large class. Whipped cream requires a lot of energy to make by hand. If the metal bowl warms up, it becomes even harder to make. All four students will have to pitch in to successfully make whipped cream. I did this myself and I really thought my arm was going to fall off! The cream must stopped being whipped when there are stiff peaks. They look like mini mountains.

Here is a picture of what that looks like from my own personal experience:

There are videos online on how to make whipped cream. Care has to be taken that the whipped cream does not turn into butter. For once the whipped cream has turned into butter, it cannot be undone.

Additional lessons:

Make mayonnaise as an emulsion. This lesson also requires a lot of energy to make mayonnaise. The ingredients are corn oil, egg whites, and lemon juice. Salad dressing can also be made.

Put flour or dirt in water and make a suspension. There are other interesting experiments you can do with corn starch. At low concentrations, corn starch can be used to make gravy. Corn starch can also be used to make "oobleck," the green rain from the Dr. Seuss book Bartholomew and the Oobleck. It is made with cornstarch and water. When it is held it feels like a solid, but a person's body temperature quickly turns the suspension into a liquid. There are many lessons that can be found online that incorporates the book with the science experiment.

Appendix A

This unit will utilize the New Haven science standard of 3.1 for third grade. This science standard focuses on materials that have properties that can be identified and described. It also looks at how heating and cooling causes changes in some of the properties of materials. Expected Performance B2 asks students to describe the effect of heating on the melting, evaporation, condensation, and freezing of water. This unit will use food to explore these content standards and expected performances.

Student Resources

These are cookbooks that have recipes that kids can do at home with their parents.

Kitchen for Kids: 100 Amazing Recipes Your Children Can Really Make by Jennifer Low. A good book that has 100 recipes that don't need knives or flames to create a dish.

Williams-Sonoma Kids in the Kitchen: Fun Food by Stephanie Rosenbaum. A good book for children ages 8 and up. This book has 25 recipes that allows children to make a complete meal and teaches about cooking.

Pretend Soup and Other Real Recipes: A Cookbook for Preschoolers and Up by Mollie Katzen. A classic book that has 17 recipes printed twice. Once in words for the adults and a second time in pictures for the kids. The focus is on natural healthy food and the process in creating them.

Cloudy With a Chance of Meatballs by Judi Barrett. A funny children's story about what would happen if food dropped like rain from the sky. The people from the town of Chewandswallow deal with issues of falling food three times a day, breakfast, lunch, and dinner and all of the problems that come with that.

Pickles To Pittsburgh by Judi Barrett (Author), Ron Barrett (Illustrator). The sequel to Cloudy With a Chance of Meatballs looks at the town of Chewandswallow after their near disaster of overflowing food and what they did with all of the extra food.

Cooking with Children: 15 Lessons for Children, Age 7 and Up, Who Really Want to Learn to Cook by Marion Cunningham. This book teaches both children and their parents the basic skills that everyone should have in the kitchen. It ranges from peeling and chopping vegetables to saut¨éing. There are 15 recipes that encourage families to cook and eat together.

Teacher Resources

On Food and Cooking: The Science and Lore of the Kitchen by Harold McGee. This excellent book is a classic. This book gives the historical, literary, scientific, and practical treatment of food from dairy to meat to vegetables. McGee gives explanations about table ingredients and their interactions with our bodies as well as the nature of digestion and hunger.

The Science of Cooking by Peter Barham. A great book that shows how a practical understanding of physics and chemistry can improve cooking skills. Each chapter starts with the scientific issues that are relevant for that food group. It also supplies great recipes to try after learning the science behind a dish.

What Einstein Told His Cook: Kitchen Science Explained by Robert Wolke. An informative and entertaining book that looks to answer approximately 130 questions regarding everyday kitchen phenomena like why water boils and freezers burn. Wolke has a humorous style in his writing using puns and other witty ways of explaining how science plays an important role in cooking.

What Einstein Told His Cook 2: The Sequel: Further Adventures in Kitchen Science by Robert L. Wolke, recipes by Marlene Parrish. The sequel to What Einstein Told His Cook, Robert Wolke continues to entertain and enlighten the reader about questions that befuddle and mystify. Questions such as how old are 1,000 year eggs and how can someone cut onions without crying? Wolke in his humorous style uses science to explain and answer such questions.

Kitchen Mysteries: Revealing the Science of Cooking (Arts and Traditions of the Table: Perspectives on Culinary History) by Professor

Herv¨é This and translated by Professor Jody Gladding. Professor This is one of the innovators who teaches about using the kitchen as a laboratory. His book answers questions people may have like, does hot pepper burn a hole in the stomach or why can't an infant be fed sausages?

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[6] Harold McGee, "On Food and Cooking," 812
[7] Harold McGee, "On Food and Cooking," 812
[8] Harold McGee, "On Food and Cooking," 814
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[25] Harold McGee, "On Food and Cooking," 818

[26] Harold McGee, "On Food and Cooking," 818

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[29] http://en.wikipedia.org/wiki/Suspension_(chemistry)

[30] Harold McGee, "On Food and Cooking," 818

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[32] Harold McGee, "On Food and Cooking," 626

[33] Harold McGee, "On Food and Cooking," 627

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[35] http://en.wikipedia.org/wiki/Emulsion