



Doing What Scientists Do While Exploring Chemical and Physical Changes

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Introduction/Rationale

I really can't recall much of science education when I was an elementary student. What I can remember was reading a science textbook and having my teacher ask questions and then send me back into the book to search for an answer. Nothing memorable about that. No wonder that I can't recall any specific science-related learning in elementary school. Since I became the teacher, I want my students to not just recall my science lessons, I want them to start stories with the words "remember the time that we...". That's my goal when delivering a lesson, running an activity, or creating a curricular unit. Instill a drive to do science, not read about it. Not watch a video about it, do science. I will continue to challenge my students to 'do science' at Kathleen H. Wilbur Elementary school.

Wilbur Elementary School is located in New Castle County, Delaware. Wilbur is a large school hosting around 1,100 students. Our students come from diverse backgrounds. They come from mansions, motels, and everywhere in between. I will be teaching in one of the seven first grade classes found at the school. In each of these seven rooms, you will find students of varying skill levels. Some will have grown as they attended years of preschool. Some will have learned much from Sesame Street, an older sibling, or an inspired parent. Other students may never have held a book before. Due to these different pre-school experiences the students coming out of kindergarten will still be across a wide band of ability levels. Typically, my class houses between 20 and 23 students. Last year I had three more girls than boys in the classroom. My class was predominantly (42%) of African-American descent. 37% of my class identified as Caucasian. The remaining (21%) were Hispanic, Asian, and Middle Eastern.

'Doing science' at Wilbur Elementary school is challenging. This is not specifically a Wilbur issue; rather the teaching of science is dictated by district priorities and pacing guides so it is a problem across the elementary schools of the district. I tend to believe that the problem spreads beyond district and even state lines. Years ago, when I began teaching in the Colonial School District of Delaware, science was afforded 30 minutes of time each day. The science block was most always placed at the end of the academic day and we educators made that work. Perhaps a decade or more years ago, the half hour at the end of the day became a shared time between science and social studies, effectively halving the time dedicated to both subjects. Educators were trusted to use this time as we saw fit provided the required learning for each area was met. The robbing

of time from science education was deemed necessary to increase the amount of time spent on reading and math, which coincidentally are tied to state testing requirements. During the pandemic, science became a package of videos that we ran for the students. A package of videos really isn't much different than when I was in elementary school as a student, and students did not get to 'do science'. The only difference being that working out of a textbook I got the opportunity to read about science, while listening to videos is even more passive than that. In the past two years, Colonial School District has invested in new science kits which combine working through slides shows of science content with the opportunity to 'do science'. I find this to be a step in the right direction, but it comes at a cost as we currently teach our three science units over three separate two-week windows across the span of the school year. This equates to us approximately teaching the science around 30-35 days of the school year. In a typical unit, there are a little over twenty activities that deliver the content related to the Next Generation Science Standards (NGSS). Our pacing only allows time to cover around half of these activities. The lessons we cannot get to simply don't get taught.

I see this unit as an opportunity to supplement the science curriculum and provide my students much needed 'do it' time. At the beginning of our school year, we typically have several days spent on building routines and developing a classroom culture. Our pacing guides do not begin during the opening week or more of the school year. I see this time at the beginning of the year a perfect time to begin establishing the routine of learning through 'doing'. Each of our science units spends valuable time focused on teaching 'What Do Scientists/Engineers Do'. I intend to address those ideas through this unit. In doing so, I am instilling a routine of doing what scientists do from the early days of the school year. Not surprisingly, much of what scientist do are things that I would love to see my readers, mathematicians, and classroom citizens do also. By starting the year building the routines of the classroom to align with the routines of scientists, I will strengthen the learning of classroom expectations and also be able to shave off the time dedicated to 'what scientists do' from each mandated science unit. That saved time can then be used to complete more of the science content in each unit within the allotted pacing.

Each science unit taught in our mandated curriculum focuses on teaching students to do the things that scientists do while they are also engaging with content. Additionally, the curriculum links scientists to engineers so my students will engage in practices employed by both groups. Specific skills that the curriculum focuses on are making observations, reading, communicating, making models, and explaining (their ideas and findings). My students will be utilizing these skills as they learn about how we change resources to suit our needs. Furthermore, the students will be introduced to the concepts of physical changes, chemical changes, and making mixtures through the activities of the unit. To add engagement and student interest in these early science activities, we will be focusing on some elements associated with ice cream sundaes.

The overarching goal of the unit is to have students be able to identify and engage in skills related to the practices of science. The unit will begin with a brief review of the things from the kindergarten curriculum that scientists do. We will also examine a phenomenon which will be the churning of cream to create ice cream. During this activity students will be engaged in the practices of making observations and communicating to explain their ideas. During the subsequent activities, students will be reading (or having read to them) children's non-fiction texts related to ice cream. In the unit, students will also be provided with definitions and examples of physical and chemical changes, as well as creating a mixture. Hands-on components of the unit will include turning graham crackers into crumbs which can become a topping and collaborating to determine that this process results in a physical change to the cracker. Another hands-on activity will focus on the toasting of a marshmallow. Since the application of heat changes the molecular make-up of the marshmallow, this act will result in a chemical change. Our final activity is the creation of ice cream, which we will do in class. Students will then collaborate and identify that that making ice cream is simply a mixture of

ingredients, and only constitutes a physical change. Throughout the hands-on activities students will be 'doing science' by engaging in the practices of observing, reading, communicating, designing an ice cream maker and explaining their thinking. Following the unit, I would expect students to be able to demonstrate a basic understanding of physical and chemical changes and mixtures. It is my expectation that my students be able to translate the skills practiced in the unit across curricular lines as I will be connecting the skills of the scientist or engineer to our classroom routines. Though I expect my students to meet this goal, I do not expect them to master these routines until later in the school year once they have been able to experience using them across curricular lines with repetition. Furthermore, I will be connecting the science across curricular lines by adding social studies learning related to history and English language arts skills through reading text and responding in a grade appropriate journal.

Content Objectives

Doing What Scientists Do

The National Science Teaching Association (NSTA) was formed in 1944 and is currently the largest professional organization that focuses on the teaching of science in the world. The group was a guiding force in developing the Next Generation Science Standards (NGSS). In November of 2025, the NSTA released a list of best practices related to science education. The biggest shift in strategy is a departure from primarily lecturing to deliver content. In its place is a focus on engaging students in science and engineering practices. This is a shift from passively receiving content to actively engaging in discovery. The NGSS are a reflection of this new approach to the teaching of the sciences. The state of Delaware public school system follows the NGSS when planning the teaching of science content. The NGSS is divided into 4 separate domains: physical sciences, life sciences, earth and space sciences, and engineering, technology, and the applications of science. This last domain is a large part of science education in the primary grades. "This domain involves the application of scientific knowledge to design solutions using engineering and technology. Within this domain are skills such as defining problems, designing and testing solutions, and critical thinking." [1] To put it simply, the NGSS mandate that students do what scientists do, in a grade and age level appropriate manner. I plan to engage my students in several science and engineering practices including making observations, and predicting, measuring, and communicating their ideas and findings.

Physical Changes, Chemical Changes, and Mixtures

Physical and chemical changes can be difficult to determine at times. However, both types of change do have distinct definitions. Physical changes change the form of the substance, but not its molecular structure. For example, an ice cube melting into water is a physical change. Both ice and water have the same molecular formula: two hydrogen atoms and one atom of oxygen. Thus, water and ice are the same substance but in different phases of matter. Another example of a chemical change is when someone breaks a first aid kit cold pack. Many of these packs contain ammonium nitrate, sealed in a plastic bag, and water surrounding that sealed bag. When the cold pack is popped, the ammonium nitrate is dissolved in the water and an endothermic reaction ensues. An endothermic reaction absorbs heat from the surrounding making those surroundings cooler. [2] Physical changes could include the changing of a substance's texture (like sanding a piece of wood), shape (possibly but cutting or stretching something), temperature (like heating metal until it glows). These types of changes do not permanently alter the substance's composition.

A chemical change is when the molecular composition of a substance is changed through breaking and forming of chemical bonds during a chemical reaction. Often the presence of certain indicators reveal that a chemical change has occurred. Examples of this indicator would include: a change in temperature, a change in color, the development of an odor, or the formation of either a precipitate (a solid substance formed by a chemical reaction) or a gas. An example of chemical change would be burning wood which releases heat and results in a transformation of wood into carbon dioxide, water vapor, and ash.[3] Chemical changes cannot easily be reversed or undone.

Mixtures are formed when multiple substances are combined together. The mixing of substances does not break or form bonds and the substances do not undergo a chemical change. A mixture can be sorted back into its disparate parts through many techniques. Some examples of these techniques would be using a magnet to remove iron filings from non-magnetic compounds, the filtration of pollutants from water, and the distillation of salt water.

Graham Crackers

Named after the clergyman and health reformer, Sylvester Graham, the Graham Cracker was invented in 1829. At the time, its ingredients included unsifted, coarsely ground whole wheat flour which was baked without fat or refined sugar. The modern-day Graham Cracker would likely be unrecognizable (and horrifying) to the health-minded Sylvester.[4] Today's commercially sold Graham Crackers commonly are made with whole-wheat flour and enriched white flour, treated with niacin, reduced iron, vitamins B1 and B2, and folic acid. Included sweeteners could be sugar, molasses, corn syrup, or some combination of the three. Soybean, canola, or palm oils and often honey are added to provide fats and flavoring. Baking soda, sodium acid pyrophosphate, monocalcium phosphate and soy lecithin are additives and leavening agents. Students will likely associate Graham Crackers with s'mores, traditionally a combination of the crackers with chocolate and toasted marshmallow. As with most crackers, the Graham Cracker is brittle and is very easy to crumble into tiny bits. The crumbs can then be combined with butter and other ingredients to make a pie crust, or as a topping to sprinkle over deserts like ice cream which we will be using it for in class. Transforming a rectangular Graham Cracker into crumbs is a physical change, and an easy example for students to wrap their head around.

Marshmallows

Marshmallows are over 4,000 years old. Initially they were used for the medicinal purposes or treating a cough, aiding digestion, and soothing irritated skin. A syrup was derived from the roots of *Althaea officinalis*, commonly known Marsh Mallow, as it was found in marshy locales. In the 1800's, marshmallow lozenges (as they were then called) became gelatin based which eliminated the need for the plant's roots. Marshmallows gained popularity in the 1920's when a Girl Scout publication promoted placing them in hot cocoa. What started as a medicine has changed over the years. What begin with a marsh plant is now a popular snack unconnected with its original purpose or recipe.[5]

A typical marshmallow is made of sugar, corn syrup, gelatin, and air. "The marshmallow is basically a foam that is stabilized by gelatin." [6] Gelatin is made by breaking down collagen which molecularly is a triple helix. When gelatin is added to warm water the heat causes the protein strands to spread out in the water. As cooling happens, the helices (helix plural) bunch back up becoming firmer, but some strands do not, and these retain their flexibility. This blend of firm and stretchy gives gelatin and thus marshmallows their texture.[7] When a marshmallow is roasted, the outer layer becomes crunchy and it turns brown (or black and flaming if you aren't careful or prefer that). While the exterior is tanning, the interior becomes very soft almost to the

point of being a viscous liquid. This transformation of the exterior is due to the properties of gelatin and a result of the Maillard Reaction. The Maillard Reaction causes browning in bread, steak, cookies, marshmallows, and many other foods. For this reaction to take place, both proteins (in gelatin) and sugar (an ingredient of marshmallows) must be available in the food being cooked. The first step of the reaction sees amino acids (found in protein) and sugar react and create a compound. These molecules form an aromatic ring which helps determine the speed of the reaction. In the final step, large complex molecules, melanoidins are formed. Melanoidins drive flavor and aroma during the cooking process and eventually give the food a brown color.[8] All of that basically means that the browning of a marshmallow during roasting is a chemical reaction involving the proteins and sugars found in a marshmallow. One interesting thing is that while the outer layer of the marshmallow is undergoing a chemical change thanks to the Maillard Reaction, the interior of the marshmallow is undergoing a physical change as the heat makes it gooey. The interior will firm up if the roasted marshmallow has the opportunity to cool.

Ice Cream

The first recipe for ice cream dates back to 1682. This early recipe called for powdered sugar and minced orange petals to be mixed in sweet cream. This mixture was to be poured in a pot. The pot was to be placed in a wine cooler and then crushed ice and salt were layered around the vessel. Over an anticipated two hours of time, the pot was to be shaken periodically to keep it from freezing solid. Frozen cream (without additional ingredients) will freeze and become as hard as rock. The addition of sugar makes the mixture softer but it comes with a lowering of the freezing point. This is problematic because, when the freezing point of the cream mixture is lower than that of water, the ice used to help freeze the concoction melts into a slush prior to freezing the cream. The salts dissolve in the slush lowering its freezing point enough that the cream mixture can be frozen and change into ice cream.[9] As early as the 13th century, the Arab world understood the effects of salts on freezing. The genius notion of the application of this knowledge of salting the ice led to the process of making ice cream. Through the late 1600s, the French improved upon the original process and recipe by incorporating a greater amount of stirring which made for a less crystalline texture. They also developed a far richer version by incorporating 20 egg yolks per pint of cream, which they called ice butter. Additionally, the French began flavoring the mixture with a variety of nuts, spices, orange blossoms, caramel, chocolate, tea, coffee, and rye bread. Another great innovation came from America in 1843 when Nancy Johnson of Philadelphia patented a freezer consisting of a large bucket for brine and a sealed cylinder for the cream mixture which had a handle and blade that allowed for continuous stirring. About a decade later a milk dealer by the name of Jacob Fussell began selling his surplus milk for the purpose of making ice cream. He sold the supply at a discounted rate. This led to large-scale manufacturing of the treat making it more accessible to masses of people.[10]

To better understand ice cream, we need to explore the chemistry involved in its creation. We can start with a look at the individual ingredients that go into the cream mixture and the substances that are foundational to the process of its making.

Milk (Fat)

There is a reason that the product we are working with is called ‘ice cream’ and that is because cream cannot be made without milk. The only difference between milk and cream is the percentage of milk fat in the liquid. The cream is the higher-fat layer that is skimmed from the milk. There are many types of cream used in a variety of cooking. With an eye toward ice cream, clotted cream has the highest milk fat percentage of at least 55%. Heavy whipping cream (which will be used in the lessons) has a milk fat percentage of no less than

36%. Half and half, which is the cream most usually put into coffee, only has a milk fat of 10-16%. Whole milk on the other hand only has 3.5% milk fat.[11] Milk fat is important to ice cream in four ways; first, during the churning fat globules trap air within the mixture (more on air later). Second, milk fat makes the mixture thicker which slows the melting time of ice cream. Third, simply put fat delivers flavor. Lastly, fat brings the creamy texture that is associated with the frozen treat.[12] Without enough fat, the overall structure of the mixture suffers due to a lack of air. Also, ice cream with insufficient fat tends to be harder to scoop and it is icier. However, a higher fat content is not always desirable. People that are counting calories may shy away from ice cream with a higher fat content. Creams with a higher fat content can be more expensive than a cream with a more modest percentage. Besides the fat, there are other components of milk that serve a purpose too. Milk also includes proteins, lactose (milk sugar), and other minerals. These components of milk help build an ice cream's body and texture. The proteins act as natural emulsifiers which help bond the water molecules to fat molecules within the mix, and help reduce the formation of large ice crystals which would give the mixture a grainy texture.[13]

Vanilla (Flavor)

Vanilla is a wildly popular flavor that is used world-wide. The use of vanilla dates back to the Aztecs who used it to flavor their drink 'xocolatl', which features cocoa and vanilla beans harvested from the vanilla orchid.[14] Since demand for the flavoring is so overwhelming, the natural supply cannot meet the demand and vanilla beans are rather expensive. Scientists isolated the molecule that gives vanilla its distinct flavor. That molecule is vanillin, an organic compound which has a chemical formula of $C_8H_8O_3$. Science has also allowed us to synthetically produce the vanillin molecule. There are two main ways to approximate the flavor of vanilla. The first is to "transform a similar molecule into vanillin: for this method, manufacturers look for components readily available, that contain a molecule that's very similar to vanillin. They then isolate the molecule and transform it into vanillin." [15] The other strategy is to **"Use a microorganism to make it:** ever since scientists found a way to use microorganisms to make insulin (essential for people with diabetes), developments have continued to happen. Manufacturers nowadays use microorganisms to make" [16] the ingredient vanillin. What to call synthetic vanilla extract varies dependent upon local laws, but most vanillin produced through molecular transformation end up being labeled as 'artificial vanilla extract'. The vanillin produced through the use of microorganisms is usually harder to define.[17] Whether the flavor comes from the vanilla orchid or the laboratory, one thing is certain, vanilla is by far the most popular variety of ice cream worldwide.

Sugar (Sweetener)

"One taste sensation is undeniably the favorite of our species and of many others in the animal kingdom from hummingbirds to horses: sweetness." [18] The most used sweetener used in ice cream is sucrose also known as table sugar. However, it is not uncommon to blend sugars together to tinker with the properties of the ice cream. Corn syrup, dextrose, glucose, and liquid glucose are common substitutes of or additions to sucrose. The obvious role that sugars play in ice cream is that they add sweetness to the product. Satisfying our sweet tooth is not the only role that sugar plays in the production of ice cream. Sugars also lower the freezing point of the mixture. They control the temperature-hardness relationship which determines how firm or soft the ice cream will be at any given temperature. Without sugar the mixture would likely freeze rock solid. The level of firmness or softness helps determine the 'scoopability' of the product when it's taken from the freezer.[19] Additionally, sweeteners increase the total amount of solids in the mixture. Solids in the mix effect the body, texture, and smoothness of the product. "More solids means less 'free-roaming' water in the ice cream - which in turn usually means less unwanted, large ice crystals in the ice cream." [20] "Ice crystals range in size

from about 1 to over 150 micrometers in diameter, with an average size of about 25 micrometers. Small ice crystals, around 10 to 20 micrometers in size, give ice cream its smooth and creamy texture, whereas larger ice crystals, greater than 50 micrometers, impart a grainy texture.”[21]

Air

During the churning process, air is folded into the ice cream mixture. Also during the process, the fat globules or micelles, from the milk, come together and form a network which traps and stabilizes air bubbles. The amount of air captured during churning is measured as ‘overrun’. ‘Overrun’ is the measure of the percentage increase in the volume over the pre-churned ingredients. So, if an ‘overrun’ measure is 100%, that means half the volume of the ice cream is the captured air. More expensive ice creams may have a lower ‘overrun’ and that results in a richer and creamier mouthful. Conversely, less costly ice cream may exceed 100% ‘overrun’ and thus would have less ingredients and more air than an equal volume of ice cream with a lower ‘overrun’. The amount of air incorporated into the mixture can also greatly affect the texture of the ice cream. Air’s most important role in ice cream is that it keeps the mixture from freezing solid and promotes a softness to the finished product.

Ice & Salt

While not ingredients in the ice cream itself, ice and salt (NaCl) have played a critical role in the process of producing the frozen treat since its earliest incarnations. Melting ice has the useful property of making things cold. “It takes energy to break the bonds that hold water molecules together in ice. If you put an ice cube into room-temperature water, the energy in the fast-moving molecules in the water will get used up making chemical bonds as molecules freeze onto it, but the molecules leaving the ice will not have a lot of energy and will be moving slower, and they will be colder.”[22] Cooling will continue until an equilibrium temperature is reached at which point cooling ceases. In pure water, this equilibrium point is reached at 32 degrees Celsius or 0 degrees Fahrenheit. However, the addition of either salt to the water (or slush or melting ice) will allow the cooling process to go below the freezing point of pure water. If salt is further added, the equilibrium temperature will bottom out at -21 degrees Celsius or -6 degrees Fahrenheit, which is the point when the water can absorb no more salt. Interestingly, sugar would also work to allow the cooling process to go below the freezing point but sugar is more expensive than salt, so salt is the preferred substance. This is why ice and salt have long been used in the process of making ice cream.

Teaching Strategies

Experiential Learning

Experiential learning is a concrete experience that engages a learner’s senses to explore the world around them. It is also hands-on learning. Following the learning, the learner must reflect on and consider the learning that has occurred. Basically, this is when my students will be ‘doing what scientists do’. This teaching strategy will occur in all three activities in the unit.

Turn and Talk

This strategy is central to learning in the primary grades. Students need to be able to communicate together,

either one-on-one or in a small group. Communication is also one of the core things that ‘scientists do’ that I would like my students to emulate. We will be using this strategy in each activity to share ideas predictions (hypotheses) about the forthcoming activity as well as to summarize our learning following the activity.

Journaling

My students will be working in a science journal to record their learning. Journaling in our class will include pictures with labels and some sentences (largely spelled phonetically). My students will conclude each activity with a journal page in an attempt to sum up their learning.

Classroom Activities

As students will be tasting things to make observations during each of the following activities, it is highly important that I know about any allergies or other reasons why a student may not be able to fully participate in the activity. In some cases, a substitution may be made that would allow the students to join in on the eating. I will be asking both the parents, and the building nurse if there are any students that need to refrain from tasting any of our substances.

Physical Change - Crumbling Graham Crackers

To introduce the unit, I will challenge the students to turn and talk with a partner about the various things that scientists do. In my district, the students will have learned about this topic in kindergarten, but even for students not specifically taught the content prior to arriving at my class I would expect that they will be able to identify some skills related to scientists. After the turn and talk is complete, I will ask students to share out the answers that either they or their partner identified. I will write these responses on chart paper to later be transferred to an anchor chart labeled ‘Things that Scientists Do’. Specific answers I will be looking for are: making observations, predicting or hypothesizing, measuring, and communicating. There are many other skills that scientists develop and use but these will be focal points in the unit activities. Should the students miss one of these focal skills of scientists, I will guide the students to those answers and include them on our chart. I will then provide each student with a ‘Science Journal’. My class will be using primary notebooks though stapling lined paper would also serve the purpose. I will explain to the students that our journal will be where we record our learning or understandings from an activity. I will invite them to use a combination of pictures, labels, or age-appropriate sentences to share their thoughts on the activity. I will explain to the students that we will ‘do what scientists do’ as it relates to a special object: a graham cracker. I will invite students to share what they know about graham crackers. Following their shares, I will hold up a graham cracker and review the history of the snack using the information found in the ‘content objectives’ portion of this unit under the subtitle ‘graham crackers’. Following the review of the history of the graham cracker, I ask the students to not eat the cracker yet. I will challenge them to draw the graham cracker in their journal and to label it with its name. Upon the completion of the journal entry, I will ask the students in what skill of a scientist they had they just engaged. They had just made an observation and recorded their findings. I will ask them which sense they used to make the observation (sight). I will then ask the students what other senses we could use to make observations. I would anticipate them jumping straight to taste, but they could also use smell or the sense of touch. The students will then engage their sense of smell to make an observation. They will also record their findings in their journal. I will assist the students with spelling by having them provide some words that relate

to the smell of the graham cracker. I will correctly spell these words on chart paper or the blackboard so that the students may properly transcribe them into their journal. I will use this method of providing correct spelling throughout the activities in the unit. The students will then repeat the process for the sense of touch and lastly, taste, recording their findings in their journal. Following that, I will provide another graham cracker to the students, with the directions to not eat it included again. I will tell the students that we will now change the graham cracker. I will ask students to volunteer ideas on how they could change the cracker. I would anticipate them suggesting that we could break them or crush them. I will provide each student with a plastic baggie and ask them to put the graham cracker inside the bag but to not seal it (I don't want them popping their bag and getting crumbs all over their workspace.) I will demonstrate how I would pulverize the cracker and then invite them to crush theirs' as well. Once crushed, I will ask the students to turn and talk to predict an answer to the following questions: has the graham cracker been changed? And is the new form still basically graham cracker? I will then instruct the students to make and record observations of the cracker crumbs using their senses of sight, touch, smell, and taste. I will ask the students if crumbs look different than a graham cracker. I would expect them to discuss the change in size from a rectangular cracker to a pile of crumbs. We can also compare the color of the crumbs to the color of the unbroken cracker. We will also compare the before and after crushing, texture, smell, and taste. I would expect them to agree that neither smell nor taste has changed. I will end the activity by informing them that the change we made to the cracker was a physical change. I will then define this term as 'a change to a substance's form'.

Chemical Change - Roasting Marshmallows

This activity is very similar to the previous one. The introduction to the activity is mildly different; instead of focusing on learning from kindergarten, I will guide student attention to the anchor chart labeled 'Things that Scientists Do' and instruct them to turn and talk with a peer about the following prompt, 'what skills did we use yesterday that are skills that scientists use also'. As the students discuss, I will circulate throughout the room asking guiding questions about which skills were used during different portions of the past activity. Following the discussions, I will call on students to share their thoughts on the prompt. We will again focus on the skills of making observations, developing a prediction or hypothesis, and communicating ideas. I will then display to the students a marshmallow. I will invite the students to share what they know about marshmallows. As students share their thoughts I will record them on a chart paper. I am positive that at some point a student will mention that they roast marshmallows over a fire. I will then present each student with a marshmallow and ask them to observe the item using multiple senses, with the last sense being that of taste. The students will record their observations in their science journal using pictures, labels, and age-appropriate sentences. I will assist with spelling. After the journaling, I will have the students turn and talk and discuss ways that they could change the marshmallow. I anticipate that the students may offer the idea of tearing the marshmallow apart. If they don't, I will suggest the strategy. I will then pull a marshmallow into pieces and ask the students if the marshmallow has been changed. I expect that they will agree that the marshmallow has undergone a change. I will ask them if they remember what words we use to describe when 'a change to a substance's form' has occurred. They should respond with the term 'physical change'. I will then ask them to draw the torn marshmallow in their journal and to label the picture a 'physical change'. I will then let the students know that there is another kind of change that scientists, or even a kid camping can bring about to a marshmallow. I will explain that this new change is known as a chemical change and that it happens when 'a substance is changed into a brand new substance, and it cannot be easily turned back into what it was before'. I will ask them if smashing a graham cracker is a chemical change. They should respond in the negative because even though the cracker pieces are very tiny after being crushed, they are still pieces of graham cracker., it is not a new substance. I will ask them about a kid camping and how that kid can cause a chemical change to the marshmallow. I will take ideas from the students. I am certain using the embedded

clue in the question, that students will identify roasting a marshmallow over a fire would cause a chemical change. I will challenge the students to predict whether the marshmallow will look, smell, taste, or feel the same after cooking. We will then roast a marshmallow. My preferred way of doing this would be to use the bus court (or another outdoor space) to set up a small grill/firepit. Given approval from the office to engage my young students near open flame, I envision drawing a circle around the source of fire. I would need to provide the students with sticks or long marshmallow skewers for the roasting. While I would position myself close to the flames, the students would remain outside of the circle roasting from a couple feet away. While I would prefer to allow the students an opportunity to roast a marshmallow, I am prepared to demonstrate roasting marshmallows should administration be more comfortable with that choice. Either way, the students should see a beautifully tanned marshmallow as well as a blackened burned marshmallow. Following the roast, I will ask the students to make observations regarding the cooked treat. I anticipate that students will identify changes to the look, smell, taste, and even feel of the marshmallow post roasting. Those observations will be added to their journal. The students will draw pictures of the roasted marshmallow and underneath said pictures, label it a chemical change.

Mixture: Physical Change - Churning Ice Cream

I expect this activity to take two class periods. To begin the final activity of the unit I will introduce and read the book *Ice Cream* by Elisha Cooper. I will challenge the students to remember different stages that the milk or cream go through to become ice cream. I will also ask them to recall some of the many ingredients the book mentions as going into the ice cream. Following the read-aloud, I will specifically go through the steps taken at the ice cream factory to transform the milk to the final product. If time allows, I may have the students draw in their journal something that stood out to them in the book and to then write a sentence that explains what is occurring in the picture that they had drawn. As the period closes, I will tell the students that during the next class they will be like the scientists in the ice cream factory, and that they will make ice cream in class.

To start the second day of the activity I will again invite the students to share some of the 'Things that Scientists Do'. I expect the students to supply the answers, make observations, make predictions or hypothesizes, and to communicate their ideas. I will then add a skill that we may not have mentioned before; scientists often read to learn about the focus of their studies, much like we read a book about making ice cream last class. I will then record "read to learn" on the 'Things that Scientists Do' anchor chart. I will then share a bit of the history of ice cream from the information located in the 'Content Objectives' section and the subsection 'Ice Cream'. I will then remind the students that in the book, *Ice Cream*, we learned that the factory uses big machines to churn the milk into ice cream. I will let the students know that we do not have a big churning machine in the classroom, but that I know another person that also does not have a giant churning machine but can make ice cream. I will show them a video of a person churning ice cream. I found many videos that featured people churning ice cream online. A simple search on YouTube should provide you plenty to choose from. Though I caution that I would not recommend showing any video to students that has not been previously viewed all the way through. I will challenge the students to recall what ingredients are churned together to create ice cream. I will then tell the students that we will use very common items to make our ice cream. I will show them quart and gallon sized Ziploc bags. I will provide each group of students 2 one-gallon bags and 2 one-quart bags. I will then direct the students to watch as I model each step in the process and then give them the opportunity to do the steps themselves as a team. I will ask the students what ingredients did the book and the video indicate are in the recipe for ice cream. I will be looking for the following ingredients: heavy whipping cream or milk, vanilla extract, and granulated sugar. I will demonstrate how to add the ingredients to one of the quart bags. I will begin by modeling how to use a measuring cup to

add one cup of heavy whipping cream to the quart bag. The student teams will use measuring cups to add the cream to the quart plastic bag. Following that I will model using a measuring spoon to add $\frac{1}{2}$ teaspoon of vanilla extract to the quart bag already containing the heavy whipping cream. The students will be provided with a $\frac{1}{2}$ teaspoon and the extract. They will add the new ingredient to their quart bag of cream. Finally, I will add 2 tablespoons of granulated sugar to the ingredient bag. I will show the students how to level the sugar in the tablespoon and I will add the sweetener to the other ingredients. The students will do the same paying special attention to measuring out the sugar called for by the recipe. I will then seal the Ziploc bag of ingredients and insert the sealed bag into the empty quart bag and seal that one as well. The students will repeat the process with their doubled quart bags full of ingredients. I will then ask the students if the person churning ice cream in the video used any additional substances to make the ice cream. The answer should be yes, if your video does not show ice and salt being used in the process, I suggest you find a video that does. I will explain that we need to use ice cubes and salt make the cream mixture change to ice cream. I will model filling one of the gallon bags half full of ice cubes. Student teams will then copy the process with one of their gallon bags. When all student groups are done adding the ice cubes, I will model measuring and adding 1 cup of rock or coarse salt to the ice cubes in the gallon bag. Student groups will complete that step also measuring the amount carefully. I will model placing the double-quart-bagged ingredients into the larger gallon bag half filled with ice and salt and then sealing the larger bag closed. The students will follow suit. Lastly, I will model placing the full gallon bag inside of the empty gallon bag and sealing it closed as well. The students will do the same. I will then distribute a dish towel to each team. I will model wrapping the towel around the sealed bags and explain that the bag of ice can get very cold as we transform the ingredients into ice cream. I will then explain that our 'churning' will actually be us shaking the bag vigorously for 5 or so minutes. I'll tell the students that when their arms become tired or their hands cold, they should pass the bag to a partner and continue. I will put some music on the Smartboard that will be good to inspire shaking the bag. While the groups shake the ingredients, I will circulate observing the cream as it thickens. When it seems that all groups have successfully 'churned' ice cream, we will remove the gallon bags over the classroom sink. We will then open the quart bags of ice cream. We will use spoons to scoop some ice cream into small bowls, which I will provide, and the students will make observations about the ice cream including, how it looks, smells, feels, and tastes. These observations can be added to our journal. I will then ask the students if the milk, vanilla extract, and sugar have undergone a physical or chemical change. I fully expect the students to suggest that a chemical reaction has taken place since the ice cream will seem like a new substance after the churning. I will explain that making ice cream is actually a physical change because we have created a mixture which is defined as 'putting two or more substances together, but they do not make up a brand-new chemical'. I will ask them to draw and label the ingredients (but not the ice and salt) in their journal and to then draw and label ice cream as well.

Resources

Bailey, R. J. *Ice cream*. Minneapolis, MN: Pogo, 2017. Non-fiction text for use with students. A detailed account of milk being changed into ice cream. Good resource for the teaching of vocabulary.

Changes in matter: Physical vs. chemical changes. Accessed July 11, 2026.

<https://education.nationalgeographic.org/resource/changes-matter-physical-vs-chemical-changes/>. This article provides definitions and examples of physical and chemical changes.

The Cold Pack: A chilly example of an endothermic reaction - let's talk science. Accessed July 11, 2026. <https://letstalkscience.ca/educational-resources/stem-explained/cold-pack-a-chilly-example-endothermic-reaction>. This article details the endothermic reaction that occurs when a first aid ice pack is used.

Cooper, Elisha. *Ice cream*. New York: Greenwillow Books, 2002. A step-by-step exploration of how ice cream is made, beginning with the healthy foods cows eat to produce good milk, and ending with a carton of frozen treat. Good for a read aloud with the class.

Crosby, Guy, Michael Newhouse, and John Burgoyne. *The Science of Good Cooking: Master 50 Simple Concepts to enjoy a lifetime of success in the kitchen*. Brookline, MA: America's Test Kitchen, 2012. Includes a recipes and information related to the science of making ice cream. For teacher background knowledge.

"Curiosity at Home - Ice Cream in a Bag." Pacific Science Center, August 1, 2022. <https://pacificsciencecenter.org/wp-content/uploads/2022/08/cah-ice-cream-bag.pdf>. Step by step instructions for making ice cream using Ziploc bags.

Dream scoops ice cream school. Accessed July 12, 2026. <https://www.dreamscoops.com/>. Science based information on the structure of ice cream and how the individual components lead to the final product.

Field, Simon. *Culinary reactions: The everyday chemistry of cooking*. Chicago, Ill: Chicago Review Press, 2012. Excellent resource which explains many chemical reactions related to cooking. Specifically, it details reactions in producing ice cream.

Food Chemistry - what is the Maillard reaction? - foodcrumbles. Accessed July 11, 2026. <https://foodcrumbles.com/maillard-reaction-mechanism-hard-core-chemistry/>. Describes the Maillard reaction which is the reason why marshmallows brown in scientific terms, but digestible.

Graham Cracker | History, s'mores, Honey Maid, crust, uses, & description | Britannica. Accessed July 11, 2026. <https://www.britannica.com/topic/graham-cracker>. The history of graham crackers and information related to the cracker.

How Vanillin is made - foodcrumbles. Accessed July 13, 2026. <https://foodcrumbles.com/making-vanillin-three-production-routes-chemistry/>. Article discusses vanillin the molecular basis of vanilla extract.

Ice crystals in ice cream — Ice Cream Science, October 20, 2016. <https://www.icecreamscience.com/blog/ice-crystals-in-ice-cream>. Website dedicated to Ice Cream science, this article focuses on ice crystals and their role in the creation of ice cream. Loads of science in this article.

Key ingredients and their roles in ice cream composition - agriculture notes by Agriculture.Institute. Accessed July 13, 2026. <https://agriculture.institute/dairy-products-iii/key-ingredients-roles-ice-cream-composition/>. A good source of information about the process and science related to making ice cream.

McGee, Harold. *On food and cooking: The science and lore of the kitchen*. New York: Scribner, 2004. Good resource for the teacher to gain background knowledge on ice cream including the invention and evolution of ice cream, the treat in the USA, the structure and consistency of ice cream, styles of flavoring, and making ice cream. A good deal of science in here.

"The Science of Ice Cream – Ice Cream Nation." Ice Cream Nation. Accessed June 17, 2026.

<https://www.icecreamnation.org/science-of-ice-cream/>. Scientific information related to the ingredients and processes used in the creation of ice cream. Good teacher background knowledge.

A snack by any other name: A brief history of marshmallows - division of historical and cultural affairs - state of delaware. Accessed July 12, 2026.

<https://history.delaware.gov/2023/11/15/a-snack-by-any-other-name-a-brief-history-of-marshmallows/>. A short history of the marshmallow largely focused on the beginnings of and changes to the marshmallow over the years.

Taus-Bolstad, Stacy. *From milk to ice cream*. Lerner Publishing Group, 2017. Non-fiction resource which follows the creation of ice cream from the cow to the grocery store. Very simplistic and straight forward.

The types of cream and their uses | U.S. dairy. Accessed July 12, 2026.

<https://www.usdairy.com/news-articles/the-types-of-cream-and-their-uses>. Highlights the varieties of cream and the milk fat percentage associated with each.

Understanding NGSS standards for Elementary and Middle School. Accessed July 8, 2026.

<https://kidsparkeducation.org/blog/understanding-ngss-standards-for-elementary-and-middle-school>. A guide to understanding the Next Generation Science Standards.

Vanilla History - Rodelle Kitchen. Accessed July 13, 2026.

<https://www.rodellekitchen.com/resources/learning/vanilla-history/>. The article relates the history of vanilla.

What's in Marshmallows, and how do the ingredients work together to make ooey-gooey treats? Accessed July 11, 2026. <https://cen.acs.org/food/food-science/s-marshmallows-ingredients-work-together/99/web/2021/04>. Article that focuses on the chemistry behind the marshmallow.

Wolke, Robert L., and Yaowanan Chetarat. *What Einstein told his Cook*. Bangkok: Matichon, 2005. An engaging book that explains elements of kitchen science. Useful for building background knowledge.

Appendix on Implementing District Standards

Next Generation Science Standards (NGSS)

Science and engineering practices (SEP) are an import part of the NGSS. These practices play an critical role in three-dimensional learning, along with disciplinary core ideas. The SEPs focused on in first grade are:

SEP 8 Obtaining, evaluating, and communicating information.

This standard is engaged with in activities one, two, and three.

Common Core State Standards (CCSS)

ELA-Literacy-SL.1.1 Participate in collaborative conversations with diverse partners and grade 1 topics and texts with peers and adults in small and larger groups.

This standard is engaged with in activity three.

ELA- Literacy-SL.1.2 Ask and answer questions about key details in a text read aloud or information presented orally through other media.

This standard is engaged with in activity three.

Delaware State Social Studies Standards

History Anchor Standard One: Students will employ chronological concepts in analyzing historical phenomena [Chronology].

This standard is engaged with in activities one, two, and three

Notes

[1] Kids Park Education.

<https://kidsparkeducation.org/blog/understanding-ngss-standards-for-elementary-and-middle-school>. (Accessed July 8, 2026)

[2] National Geographic.

<https://letstalkscience.ca/educational-resources/stem-explained/cold-pack-a-chilly-example-endothermic-reaction>. (Accessed July 11, 2026)

[3] National Geographic.

<https://education.nationalgeographic.org/resource/changes-matter-physical-vs-chemical-changes/>. (Accessed July 11, 2026)

[4] Britannica.com. <https://www.britannica.com/topic/graham-cracker>. (Accessed July, 11, 2026)

[5] State of Delaware.

<https://history.delaware.gov/2023/11/15/a-snack-by-any-other-name-a-brief-history-of-marshmallows/>. (Accessed July 12, 2026)

[6] Chemical & Engineering News.

<https://cen.acs.org/food/food-science/s-marshmallows-ingredients-work-together/99/web/2021/04>. (Accessed July 11, 2026)

[7] Ibid.

[8] Foodcrumbles.com. <https://foodcrumbles.com/maillard-reaction-mechanism-hard-core-chemistry>. (Accessed July 11, 2026)

[9] Harold McGee, *On Food and Cooking: The Science and Lore of the Kitchen*, 39.

[10] Ibid., 40.

- [11] USA Dairy.com. <https://www.usdairy.com/news-articles/the-types-of-cream-and-their-uses>. (Accessed July 12, 2026)
- [12] Dream Scoops.com. <https://www.dreamscoops.com/>. (Accessed July 12, 2026)
- [13] Agricultural Institute. <https://www.icecreamscience.com/blog/ice-crystals-in-ice-cream>. (Accessed July 13, 2026)
- [14] Rodel Kitchen.com. <https://www.rodellekitchen.com/resources/learning/vanilla-history>. (Accessed July 13, 2026)
- [15] Foodcrumbles.com. <https://foodcrumbles.com/making-vanillin-three-production-routes-chemistry>. (Accessed July 13, 2026)
- [16] Ibid
- [17] Ibid
- [18] Robert Wolke, What Einstein Told His Cook, 5.
- [19] Agricultural Institute. <https://www.icecreamscience.com/blog/ice-crystals-in-ice-cream>. (Accessed July 13, 2026)
- [20] IceCreamNation.org. <https://www.icecreamnation.org/science-of-ice-cream/>. (Accessed June 17, 2026)
- [21] IceCreamScience.com. <https://www.icecreamscience.com/blog/ice-crystals-in-ice-cream>. (Accessed June 17, 2026)
- [22] Simon Field, Culinary Reactions: The Everyday Chemistry of Cooking, 227-228.

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