Doing Science by Inquiry-Based Learning

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James Martin Middle School

This curriculum unit is recommended for:
Eighth Grade Science

Keywords: Matter, Physical Properties, Physical Changes, Chemical Properties, Chemical Changes, flammability, combustion, reactivity, melting point, boiling point, solubility, precipitate, ductile, malleable, acid, base, pH

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This unit focuses on developing scientific thinking to facilitate a deeper understanding of science concepts. This unit will promote critical thinking by utilizing the scientific process. Students will explore the concepts of matter through hands-on activities (labs) and demonstrations. Throughout the unit, students will explore the difference between physical and chemical changes through mini-lectures, labs, and demonstrations. Students will develop scientific strategies, how to apply these strategies and how to communicate their results as a scientist. These strategies include the understanding and development of the scientific method.

I plan to teach this unit during the coming year to 120 students in eighth grade science.

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Introduction

Middle school students cannot conceptualize the importance of chemistry. Chemistry is in everything we do in life. Chemistry is studying matter. The students have difficulties comprehending not only chemistry concepts but also many concepts especially those concepts requiring critical thinking. Students are accustomed to worksheets. My eighth grade students are comfortable with the "sit and get" classroom mentality. This unit focuses on developing scientific thinking to facilitate a deeper understanding of science concepts, particularly matter. The unit will promote critical thinking by utilizing the scientific process as the students examine physical changes and chemical changes. This curriculum unit will take approximately one week to complete. The pacing for this curriculum unit is based on seventy-five minutes per block. The science classes meet every day.

Rationale

This unit is designed for eight grade students. Building relationships with my students will be important to the success of learning science through inquiry-based techniques. Children need to feel successful to thrive. Inquiry-based learning may intimidate students; therefore, building a strong relationship with my students is paramount. My students must feel safe in the classroom to generate their questions and find their own answers. My students need to recognize it is ok to make mistakes, regroup, and re-strategize to gain a full understanding of the concepts. This will promote critical thinking skills. Once I have established a strong relationship with my students and identified their learning styles and strengths, then lessons can become more personalized. Students want to feel successful and capitalizing on students' strengths is paramount to success in any classroom.

Doing science increases problem solving skills and critical thinking skills for students. It prepares them for a STEM driven society. For students to have an advantage over others, they must have the exposure to inquiry-based learning to enhance their ability to solve problems. Instruction needs to move beyond being compliant when learning to do science to develop the habits of scientific thinking. This is also a challenge for teachers. Most traditional lessons center around is guided practice then independent practice. This model does the thinking for the students. Students then become dependent on the guided portion of the lesson. However, as teachers, we need to allow our students to become independent thinkers by creating the environment and lessons requiring students to do the thinking prior to the teacher telling them how to think. Another challenge teachers face is when we are observed the mindset is the guided practice prior to the independent practice is the "right way" to teach students; however, it is not always a best practice especially when we are demanding that our students think on their own. The inquiry base teaching model is the model will shift in thinking and teaching our students (1).

The unit will first focus on scientific thinking, the process we go through to answer questions we have about science concepts. Students will engage in hands-on (demonstrations and/or experiments) science and discussions. However, students must first learn how to think scientifically (the scientific method) and how we process concepts scientifically. The unit will not only be an introduction of the scientific method but also how do we apply the scientific method to our eighth grade curriculum. The state curriculum does not give the scientific method as an unpacked essential standard nor does the state test cover the scientific method. However, students have to be able to extrapolate the basic science concepts and apply them to different scientific scenarios and situations on the state test. Some teachers in the lower grades do skip teaching the scientific method partially because it is not addressed in the essential standards but also because it is not included in the end of the year tests. I would like to engage the students throughout the year with learning science using inquiry strategies. Learning science through inquiry-based strategies will be incorporated throughout the year especially when the foundation is set for the expectations of the class and for the basic learning of the scientific process.

School and Student Demographics

Currently there are 1061 students enrolled at James Martin Middle School. James Martin Middle School is located in the northern part of Charlotte. Its student population consist of 63% African American, 27% Hispanic and a combination of Asians, whites, American Indian, Pacific Islander, and two or more races. James Martin is a Title I school and is part of the Beacon Learning Community. The entire school receives free lunch due to the socio-economic status in our school zone. I have some students that cannot speak English and the language barrier is definitely a challenge because students do not receive any support in science classes although it is expected from the state every student take the end of the grade test in science.

According to the 2016, North Carolina Schools Report Card James Martin obtained an overall grade of D (47%). It is also documented the school made 80.8% growth. The 2016 proficiencies for the school are as follows: reading 40%; math 26% and science is 61%. Of the 61% of proficient students in science, almost half of the students are college and career ready. The percentage for college and career ready in science is 49.6%.

The eighth grade population consists of 30.4% of the school population. There are 327 eighth grade students. Of those 327 students, 183 are males and 144 are female students. To break down the eighth grade population even more; we have 199 (18.5%) African American students, five (0.5%) Caucasian, 101 (9.4%) Hispanic, three (0.3%) American Indian, 15 (1.4%) Asian, one (0.1%) Pacific Island and three (0.3%) students considered two or more races. We have a total of 41 (3.8%) students with disabilities, only four (0.4%) students are considered academically gifted. Thirty-six (3.3%) students are English as Second Language students. We group our students on three different teams. We have the team that teaches Math I. We have 74 students enrolled in the Math I class. This class is a high school credit class. This team also teaches half of the students with disabilities. Then we have another team, which teaches the higher-level students and the other half of the students with disabilities. Then we have the team that teaches the students classified as English as Second Language students and this team also teaches the students who struggle academically. This team is my team. My team has the students who struggle academically and struggle with language.

Students can learn the science concepts at James Martin; however, they could learn at a much higher rate if they were developing their critical thinking skills. As a result, creating a science curriculum promoting scientific thinking will increase independent learners who will thrive and increase their critical thinking skills. Learning science through inquiry-based strategies will support doing science.

Curriculum/Goals

I teach according to the North Carolina Essential Standards for Middle School. During the first quarter, the students and I focus on chemistry. Concentrated here is standard 8.P.1.3, which involves comparing physical changes such as size, shape and state to chemical changes that are the result of a chemical reactions that result in changes in temperature, color, or the formation of a gas or precipitate. It addresses how matter can experience either physical changes or chemical changes or both. Although the introduction of this essential standard begins in the sixth grade, our students at James Martin have challenges with comprehending and retaining many concepts from grade to grade particularly when the concepts get more and more complex. In addition, our students in the eighth grade rarely, if ever, have done a lab using the scientific method.

Being able to differentiate between a physical property and a chemical property is also in this standard. Differentiating between physical and chemical properties can be difficult for some students to grasp. Students first need to be able to distinguish between a physical property and a chemical property. Once students understand how to differentiate between physical properties and chemical properties, teaching them how to differentiate between physical and chemical changes is the next concept students need to master (2).

This essential standard also describes that physical changes do not change the chemical arrangement of the matter. Students will need to understand the definition of physical properties. For example, if you rip a piece of paper, then it is still paper. In chemical changes, different substance(s) develop. Students will identify when a chemical reaction has occurred by determining if the substance is broken apart of if when substances are combined, at least one new substance is formed. For example, cooking is a chemical reaction. When you bake a cake, you combine the eggs, milk, butter, flour, sugar and other ingredients and once you bake the ingredients you now have a cake. Students need to understand chemical properties can be recognized only when substances react or do not react chemically with one another when the matter experiences an alteration in arrangement of the matter (3).

Content Research

Physical properties are observed and measured without changing the kind of matter examined. The physical properties studied are shape, density, solubility, odor, melting point, boiling point, and color. Chemical properties are used to help identify a substance. The chemical properties we discuss in middle school science are the ability of a substance to react with oxygen and with acids.

The temperature when a pure substance melts is the same under constant conditions. (Pure substances are discussed prior to this essential standard. Therefore, students are familiar

with the terminology.) Hence, the melting point for a pure substance is used as a physical property for identification. Ice melts to form water at 0°C (32°F). In addition, you can use boiling points to identify a substance. Another physical property, density can help classify a substance. Density is the property that describes the relationship between the mass of a material and its volume. Substances that have higher densities contain more matter in a given volume. The density of a substance will stay the same no matter how large or small the sample of the substance, and therefore, density is used as a physical property for identification of the substance. For example, the density of lead is much greater than the density of aluminum. Color is also a physical property. Color is used to help identify a substance, along with other properties. By itself, color is not a significant identifier of a substance. Absence of color is also a physical property (3).

Chemical properties can be recognized only when substances react or do not react chemically with one another, that is, when they undergo a change in composition. A chemical property of one substance usually involves its ability to react or not react with another specific substance. Two examples of chemical properties include, reacting with oxygen and reacting with acids. The ability of a substance to burn is a chemical property that involves a substance reacting quickly with oxygen to produce light and heat. Reacting with oxygen slowly occurs when iron rusts or apples turn brown. Reacting with acids is another chemical property we teach the students in the eighth grade. The ability of a substance to react with an acid is a chemical property. Some metals react with various acids to form compounds. Not all metals react with all acids. Bases react with acids to form water and neutralize the acid (3)

Physical changes do not change the composition of a substance, only the physical properties. Evidence of a physical change includes a change in the state of matter. When a substance changes from one state of matter to another (for example, changing from solid to liquid, from liquid to solid, or from liquid to gas), the composition of the substance remains the same. Examples of change in state might include melting of ice cream, hardening of melted wax, or the evaporation of water from wet clothes. When a substance changes directly from a gas to a solid (the forming of frost from water vapor) or from a solid to a gas (dry ice, solid air fresheners), that change of state is called sublimation. This is still a physical change because the composition of the substance remains the same (3).

Another physical change students need to understand is the change in size or shape is a physical change. Examples include when a substance changes in size or shape (for example, cutting, tearing, dissolving, stretching, or wrinkling), its composition remains the same. Examples of change in size or shape might include: shredding paper, dissolving sugar in water, stretching a rubber band, wadding up a piece of paper, or denting a piece of metal (3).

Chemical changes result in the formation of one or more new substances with new chemical and physical properties. Indications that a chemical change may have occurred include color change, temperature change, formation of a precipitate and formation of a gas. When a substance changes color, the chemical composition of the substance may have changed (for example, iron turns to a reddish-brown when it rusts, apples brown when they react with oxygen in the air, or marshmallows turn black when burned). Occasionally, it is reasonable to have a color change without a chemical change. Adding food coloring to frosting is an example of this

occurrence. Another chemical change is temperature change. When a substance is combined with another substance, there may be an increase or decrease in temperature (for example, when wood burns to ash and gases, the temperature increases). Again, you can have temperature change without a chemical change. For example, warming your bath water is not a chemical change. Formation of a precipitate is a chemical change. When two solutions are combined, they might form a solid substance. This solid substance is called a precipitate and specifies that a chemical change has happened. An example of this chemical change is when carbon dioxide is combined with aqueous calcium hydroxide (limewater). Solid calcium carbonate (chalk) is formed as the precipitate in this reaction. The precipitate may be in the form of very small particles, appearing as cloudiness in the solution or as a solid which settles to the bottom of the container. Lastly, the development of a gas is a chemical change. When solid or liquid substances are combined, they might produce gas bubbles. The formation of the gas may indicate that a chemical reaction has taken place. For example, when vinegar is added to baking soda, it forms carbon dioxide bubbles. This demonstration is simple to do with students because of the ease of obtaining the materials and the safety factor. Again, it is possible to form gas without a chemical change. For example, when water is heated to boiling, a gas forms without a chemical change (3).

Teaching Strategies

The curriculum unit is broken into three parts. First, students will become more familiar with the scientific process. Next, students will begin to move beyond theory to fully understand inquiry-based science using teacher-guided demonstrations. Finally, they will put theory into practice by completing experiments. Many of my students are not accustomed to labs in the science classroom; therefore, students will need guidance to help them be successful.

Vocabulary Development

Vocabulary development is essential to understanding the content of the unit for all students but especially for my students who do not speak English. The class contains several English language learners that have limited English vocabulary and often struggle with science terminology. Vocabulary development through definitions, drawings and flash cards will be utilized to help students understand key concepts along with key vocabulary.

Demonstrations

Teacher demonstrations are essential to science. Students need to see concepts rather than only reading about science concepts. When teachers demonstrate the science concept, it develops a deeper understanding for students. Students are able to grasp complex concepts when they can visualize the concept in action. Teacher demonstrations are also important because it also can serve as an example for students to follow. Additionally to students developing vocabulary through definitions, illustrations and flash cards, students will gain a better understanding through demonstrations. The demonstrations will reinforce some terminology.

Hands-on Experiments

Hand-on experiments are now the exception for middle school science when it should be the norm. Hands-on experiments peak students' interest in science. This encourages students to think beyond the paper and pencil model of learning. When you require students to complete the hands-on experiments, students show their thinking. Students have to describe, plan, and reflect on the science concepts presented in the hands-on experiments. Hands-on experiments challenge the learner's thinking and they promote critical thinking skills. Many students struggle with critical thinking skills; therefore, this is a key component to encouraging students to think on their own (1).

Instructional Implementation

I see my students five times each week for seventy-five minutes. I will teach the lessons described in this section over four class periods.

Lesson 1

Students will be introduced to the scientific method. Students will make observations, determine a problem (scientific question), form a hypothesis, collect and record data, conduct an experiment, and analyze data and draw conclusions is the way scientists learn about the world around us. First, I will provide notes about the components of the scientific method (Appendix 2) to the students. Due to time constraints we will not have the opportunity to explore each aspect of the scientific method individually subsequently students will incorporate the steps of the scientific method as we explore physical and chemical changes.

Students will complete a Flocabulary assignment. Flocabulary is an online program. The program uses hip-hop music to engage students. Flocabulary has a lesson on physical and chemical changes. Students will listen to the hip-hop physical and chemical changes song then complete the vocabulary cards for this lesson. The assignment is for students to use the word in a sentence demonstrating their understanding of the vocabulary words then draw a picture, which correlates with the sentence and the meaning of the word.

Teacher demonstration. The teacher will explain physical properties to the students. The teacher will dissolve sugar into water. This is an example of solubility – a physical property. Then an example of a chemical property will be presented to the class. The teacher will burn a piece of paper. Flammability is a chemical property. The teacher and the class will discuss physical and chemical properties.

Lesson 2

To engage students in exploration of concepts and generate critical thinking, demonstrations will be used to help students make connections and explore applications of the concepts of physical and chemical changes.

Teacher demonstration. The teacher will demonstrate the difference between physical and chemical changes. The teacher will rip up a piece of paper. The teacher will burn a piece of

paper. This will lead into the discussion about the paper. Is the ripping of the paper changing the paper's composition? Is burning the paper changing the paper's composition?

Students will continue to build their understanding of physical and chemical changes through vocabulary development. Students will use Flocabulary to complete an assignment. Students will read and respond to eight short reading passages. The reading passages focus on the vocabulary words the students completed in lesson one. https://www.flocabulary.com/

Lesson 3

To engage students in exploration of concepts and generate critical thinking, demonstrations will be used to help students make connections and explore applications of the concepts of physical and chemical changes.

Vocabulary development in this lesson is a vocabulary quiz. Students will answer questions using Flocabulary's quiz. https://www.flocabulary.com/

Demonstration 1: The Fluorescence of Tonic Water

Tonic water is clear and colorless in typical classroom lights, but it glows when exposed to an ultraviolet (black) light. Students will make observations about the tonic water. It is a clear, colorless liquid. Then students will make observations about the tonic water after the classroom lights are turned off and an ultraviolet (black) light is shone on the tonic water. The tonic water appears to be fluorescent blue in color when it is illuminated by the ultraviolet light. Students will discuss the observations of the water. Students will discuss why the water is colorless under the regular classroom lighting and glowing fluorescent blue under the ultraviolet (black) light (see Figure 1). The students learn the tonic water has an ingredient in it called quinine, which creates the fluorescent blue color under the ultraviolet (black) light.

Figure 1: At left, tonic water seen under normal classroom light. At right, the tonic water when illuminated by the black light.

Students will record their findings in their science notebook. Students will discuss the changes in the tonic water. Why do you think the tonic water changes color under ultraviolet

light (black light)? Does the composition of the tonic water change? Hence, the connection to the vocabulary words (physical change) is made. Is this a physical or a chemical change? Students could even be allowed to drink the tonic water before and after the demonstrations so they understand the original state of matter has not changed in the tonic water.

The tonic water glows blue when it is illuminate by the black light because this light adds energy to the quinine molecules. The molecules absorb energy and this moves the electrons around (to higher energy levels) in the molecule. The electrons then release energy by giving off light. This process is called fluorescence.

Demonstration 2: Glow Sticks

Glow sticks have a bunch of tiny glass tubes filled with one chemical. The plastic part is made of another chemical that creates ultraviolet light. When the two chemicals interact then a chemical reaction happens and light is given off (see Figure 2). This demonstration illustrates a chemical change. The students will make observations of the glow sticks prior to "breaking" the glow stick then afterwards. The class discussion will focus on the liquid. Why does the stick light up? What are the chemical properties causing the reaction? Is this a chemical change?

Figure 2: Glow sticks give off light after two substances are allowed to chemically react.

At the end of class, students will complete the do now and exit ticket (Appendix 3) to demonstrate their understanding of physical and chemical changes.

Lesson 4

Students will explore more physical and chemical changes with stations. At each station students will to do a short experiment, make observations and then use their prior knowledge from the demonstrations and vocabulary to determine if they are observing physical or chemical changes.

This activity takes some prep work prior to class. The stations are set up around the classroom. The class is divided into groups of four or five students. Each group will travel from station to station to perform all the activities. The students will record their observations on the student physical and chemical changes station sheet. This activity will take the entire class period. Students will spend five to seven minutes at each station. Students need the opportunity to explore each station. Once the students have completed the stations, then there is a class

discussion on their observations. Appendix 4 has the student sheet and the teacher sheet for the activities. Appendix 5 has the station cards. These stations can be printed off on card stock and laminated for durability.

Assessment

Students will be assessed both formally and informally. Informal assessments will be exit tickets and do nows. The exit tickets and do nows help determine the level of understanding and the adjustments that need to be made prior to proceeding to the next concept. Students are also assessed with the stations. The students will make observations then determine if the change is a physical or a chemical change. Students will also be assessed with quizzes and common assessment using the Schoolnet. These assessments are already created and shared on the CMS Secondary Science Wiki.

Appendix 1: Teaching Standards

8.P.1.3 Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.

8.P.1.3 Unpacking – What does this standard mean a student will know, understand, and be able to do?
Physical properties can be observed or measured without changing the chemical composition of an element. Physical properties include melting and boiling point, density, solubility, polarity, malleability, ductility, conductivity, specific heat, and color.

Chemical properties are only observed during a chemical reaction. Chemical properties include reactivity, pH, flammability

8.P.1.3 Essential Questions
Explain the difference between a physical and chemical property.
Explain why a change of state (phase change) is a physical property.
How do physical and chemical properties differ?

8.P.1.3 Students will be able to identify the properties of matter.

Appendix 2: Science and Scientific Method Student Notes

Notes: Science and the Scientific Method

What is **science**?	• Information gained by **observing**
	  o **Observations** help create scientific laws and principles
	  o These scientific laws and principles can be confirmed or tested

Observations	• Information obtained by your senses
	  o Touch
	  o Smell
	  o Sight
	  o Hearing
	  o Taste

What is **chemistry**?	• The study of **matter** and how matter interacts with other **matter**. • **Matter** o Anything that has mass and takes up space
What is the **Scientific Method**?	• A process scientist use to research and answer questions • Steps of the **scientific method** 1. Ask questions 2. Research 3. Generate a hypothesis (an inference) 4. Check the hypothesis by performing an experiment 5. Collect data 6. Study the data (results) 7. Make conclusions based on the data observed 8. Share your results
Ask Questions	• Ask questions to determine what you want to find out
What is a **hypothesis**?	• An **inference** using the information gained from the research and the **observations** • Can be checked to either support your claims or not support your claims
How do you test a **hypothesis**?	• How do you plan to answer your question? • Create an experiment to test your **hypothesis** (**inference**) • Experiment phase of the **scientific method** • Testing the **hypothesis** must be repeated many times

Variables	• A feature in the experiment that could change or alter the results of the experiment
	  o **Independent Variable** – the factor altered by the person doing the experiment. This the **variable** being tested.
	  o **Dependent Variable** – the part of the experiment changed to test the **hypothesis**. The result of what the scientist changed. It is the effect of what happened in the experiment.

Gathering **Data**	• Make **observations** using all of your senses to collect information
Data Analysis	• Collect your **data** with the **observations** you made • Write down your **observations** to help you look at the **data** and determine what the **data** says about the experiment

	• Be consistent with recording the results • Using your **data** create tables, charts, illustrations

Conclusion	• Do your **data** support your **hypothesis**?
	  o Why does it support your **data**?
	  o Why does it not support your **data**?
	• How can you improve your experiment?
	• Restate why you are doing the experiment
	• Communicating the results of your data is important
	• Explain what you discovered during the experiment
	• Does the experiment lead you to more questions?
	• What will you do with your research?

Appendix 3: Physical and Chemical Changes Do Now and Exit ticket

Physical and Chemical Changes Exit Ticket

1. Which is an example of a physical change?

A. Wood burning
B. Iron rusting
C. Ice melting
D. Milk souring

2. Which is an example of a chemical change?

A. Wood burning
B. Rocks weathering
C. Ice melting
D. Boiling water

3. **Explain in your own words what the difference is between physical and chemical changes.**

Answers will vary

Physical and Chemical Do Now

Directions: Categorize the following as a physical change or a chemical change:

Example	**Physical or Chemical Change**
Your bicycle rusts after leaving it outside	
Salt dissolves in water	
Burning charcoal for the barbeque grill	
Cutting the grass	
Melting butter	
Baking a cake	

Appendix 4: Physical and Chemical Changes Stations (Student Sheet and Teacher Sheet)

Physical or Chemical Changes Student Data Collect Sheet

Station	Observations	Physical or Chemical? Your Explanation
1		
2		
3		
4		
5		
6		
7		
8		

Physical or Chemical Changes Teacher Answer Key

Stations	Title	Materials	Physical/ Chemical
1	Ice	• Ice cubes • Clear cup	Physical
2	Balloon	• Balloons	Physical
3	Sugar Water	• Sugar • Water • Beakers • Stirrers • Waste Container	Physical
4	Magnetism	• Magnet • Iron Filings	Physical
5	Pennies	• Pennies (tarnished) • Lemon Juice • Medicine Dropper • Paper Towels	Chemical
6	Alka-Seltzer Tablets	• Alka-Seltzer tablets • Container of water (marked “Clean” • Beaker (100 - 200 ml) • Waste Container	Chemical
7	Bread	• Bread • Eggs • Flour • Yeast • Small containers	Chemical
8	Steel Wool	• Steel wool (soak in water for a few days)	Chemical

Appendix 5: Physical and Chemical Changes Stations (Student Sheet and Teacher Sheet)

Station 1 – Melting Ice

- Observe the ice in the cup and record.
- Is the ice changing? How?
- Compare the color of the liquid in the cup to the color of the solid ice.
- Are you observing a physical or chemical change?

Station 2 – Blowing up a Balloon

- Take a balloon and blow it up about half way.
- Is this a physical or chemical change?
- Take the balloon with your hand and squeeze it into a new shape.
- Is this a physical or chemical change?

Station 3 – Dissolving Sugar

- Fill the small container about one-half full of water and put one teaspoon of sugar in it.
- Stir until most or all the sugar is dissolved.
- Write your observations.
- Is this a physical or chemical change?

Station 4 – Observing Magnetism

- Use the magnet to move the iron filings around.
- What happens? Is this a physical or chemical change?

Station 5 – Tarnished Pennies

- Take a tarnished penny and place five drops of lemon juice on it.
- After a few minutes, rub it gently with a paper towel.
- What happened? Is it a physical or chemical change?

Station 6 – Alka-Seltzer Tablets

- Fill the beaker with water from the clean water container.
- Drop in one of the Alka-Seltzer tablet
- Observe what happens.
- Write your observations.
- Is this a physical or chemical change? Explain your answer.

Station 7 – Bread

- Look first at the bread
- Look at the ingredients we make bread with and make observations.
- Compare the product, the bread, with its ingredients, the flour, eggs, and other things you see.
- Write your observations.
- Is making bread a physical or chemical change? Write down your observations.

Station 8 – Steel Wool

- Observe the steel wool in water.
- What is the brown substance?
- Are you observing a physical or chemical change?

Resources for Students and Teachers

CMS Secondary Wiki. Accessed October 1, 2017. http://hsscience.cmswiki.wikispaces.net/8th+Grade. More information on physical and chemical changes.

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A Leader's Guide to Science Curriculum Topic Study. Accessed August 21, 2017. http://scnces.ncdpi.wikispaces.net/file/view/CTS%20Guide_NC%20Matter%20Properties%20and%20Change_Version3.pdf/615902603/CTS%20Guide_NC%20Matter%20Properties%20and%20Change_Version3.pdf. Matter: Properties and Change Standards- and Research-Based Study of a Curricular Topic.

Flocabulary. Flocabulary is a learning program for all grades that uses educational hip-hop music to engage students and increase achievement particularly in vocabulary. https://www.flocabulary.com/unit/physical-chemical-changes/. This Flocabulary focuses on physical and chemical changes.

Endnotes

(1) A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, page 10.

(2) North Carolina End of the Grade 8 Science, James Martin Accountability and test results, SAS® EVAAS™ (Education Value-Added Assessment System).

(3) North Carolina Essential Standards 8 Science.

Annotated Bibliography

A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Outlines a broad set of expectations for students in science and engineering in grades K-12.

North Carolina Essential Standards 6-8 Science. Unpacked content of the eighth grade curriculum. This details the content and how much detail the teacher needs to address when teaching each concept.