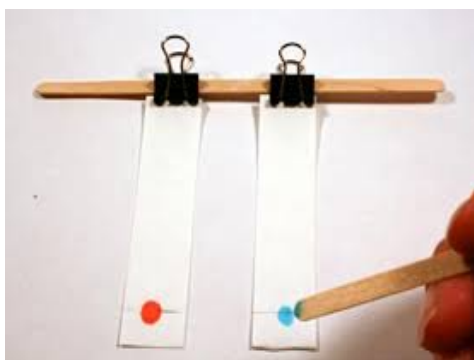




Sweet, Sweet Science



*Developed by Morgan Carney
Designed for Grades 6, 7, and 8
July 2019*

I. Introduction

a. Rationale

This unit focuses on the essential understanding that “innovation drives change”. This idea applies not only to food science and experimentation, but to so many realms of life from technological development, to language creation, to the invention of social media, to the development of new medicines and cures for illnesses. It is crucial for students to engage with these concepts, particularly in our present-day world where change is both constant and rapid. Additionally, the content and skills involved in food science provide a unique, interdisciplinary approach to scientific understanding and discovery. The sequenced task of developing, baking, rating, and marketing a cookie recipe involves concepts of mathematics, chemistry, biology, physics, marketing, psychology, innovative and entrepreneurial thinking, creativity, literacy and more. The idea of viewing food as an opportunity for education and learning is engaging for learners of all ages, and opens doors to conversations and personal reflections about science, culture, innovation, and beyond.

b. Differentiation for Gifted Learners

Dimensions of Differentiation: While this unit was designed for an AIG summer camp learning environment, it would be appropriate to use this unit in many contexts with gifted students. The curriculum is designed specifically for gifted learners, so it would be ideal to use these lessons in a learning environment consisting of students who have been identified as gifted. This unit contains some reading assignments and articles that feature advanced content differentiation, above and beyond the standard knowledge and understanding of a middle school student. The readings contain more complex ideas, as well as some advanced vocabulary. Through the various lesson plans, students will engage in a plethora of challenging

process skills, from utilizing the Taba model of sorting, naming, regrouping, subsuming, and generalizing their ideas to investigating concepts through the role of a scientist in a Bruner model lesson. Additionally, the final phase of the unit will require students to collaborate in teams to not only develop and create unique cookie recipes, but also to generate their own rubrics to evaluate all of the class recipes and use both quantitative and qualitative analyses to determine the best cookies. This product differentiation provides rigor that is appropriate for gifted middle school students.

Features of Differentiation: Through the various labs and activities in this curriculum unit, students will engage in the complexity of thought required by true scientists and food chemists. They will work to understand higher-level concepts from chemistry and physics, and will put those ideas into action through labs like the candy chromatography lab, which requires them to analyze pigments in different hard candies through a scientific process called chromatography. Through the Bruner lesson, students will dive deeply into understanding the role, traits, personality, tools, and experiences of a scientist. Students will also be asked to tap into their creativity during the cookie creation problem-based learning and performance task component of this unit.

c. Intended Population

This unit was originally designed for students from Durham Public Schools in Durham, North Carolina, as part of the Spark Summer Camp for gifted students. It was developed specifically for a wide-range of students from various socio-economic and cultural backgrounds, and for students at a middle school level who have already been identified as gifted learners. These students were seeking engaging learning opportunities that would provide an experience engaging with topics and ideas outside of their regular classroom experiences. Because these

students were coming from different elementary and middle schools all around the county, some of them may have had wonderful, engaging educational experiences that have catered well to their needs as a gifted student, and some of them may not have these opportunities. Spark Camp provides an opportunity for all of these students to come together and be surrounded by their intellectual peers in an exciting, inviting, and intellectually engaging environment.

This unit is ideal for learners who are interested in science, discovery, exploration, and food, but it is designed to be accessible to all learners, even those who do not have a strong background in any of these topics. All of the lessons and activities revolve around the concept that “innovation drives change” and relate in some way to food science, so students who have an innate interest in cooking or in engineering or who are creative and innovative will find this unit particularly engaging. In addition, through the concept-based learning lens, students will have the opportunity to bring a plethora of prior knowledge and experiences to the table to contribute to class conversations and discussions, again, even if they do not have a wealth of direct experience with scientific discovery, innovative thinking, or food science. Students will be able to connect with the concepts of innovation and change from multiple viewpoints; for example, a student with an interest in world history may bring ideas about the rise and fall of empires to class discussion about change. This concept-based approach makes this unit accessible for learners with any level of scientific background.

II. Goals and Outcomes

a. Content Goals and Outcomes

- i. GOAL 1: To compare physical changes to chemical changes, and related these ideas to the concepts of innovation and change
- ii. Science 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.
- iii. Students will be able to...
 - 1. Analyze characteristics of physical and chemical changes
 - 2. Summarize the similarities and differences between different types of change
 - 3. Draw conclusions about a change based on the result of an experiment
 - 4. Identify substances based on their reactions and changes to particular stimuli such as water and heat
 - 5. Discuss and defend their ideas about how innovation relates to and can drive change

b. Process Goals and Outcomes

- i. GOAL 2: To develop skills of a food scientist
- ii. Students will be able to...
 - 1. Compare and categorize ideas
 - 2. Summarize data and information
 - 3. Draw conclusions and clearly state their thoughts
 - 4. Safely follow procedures for a lab, experiment, or activity
 - 5. Apply information to new situations
 - 6. Collaborate with a team

c. Concept Goals and Outcomes

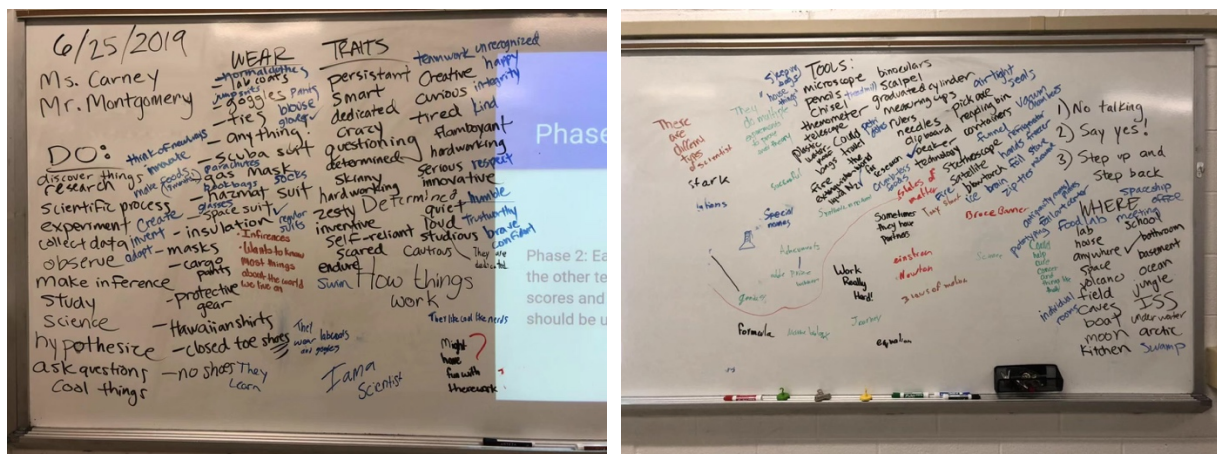
- i. GOAL 3: To understand the concepts of innovation and change
- ii. Students will be able to...
 - 1. Utilize new ideas and vocabulary to describe the relationship between innovation and change
 - 2. Develop new ideas by using innovative thinking and using change to alter a recipe or formula
 - 3. Apply their knowledge and understanding of change to unique situations and contexts
 - 4. Discuss innovation and change from the viewpoint of a scientist

III. Assessment Plan

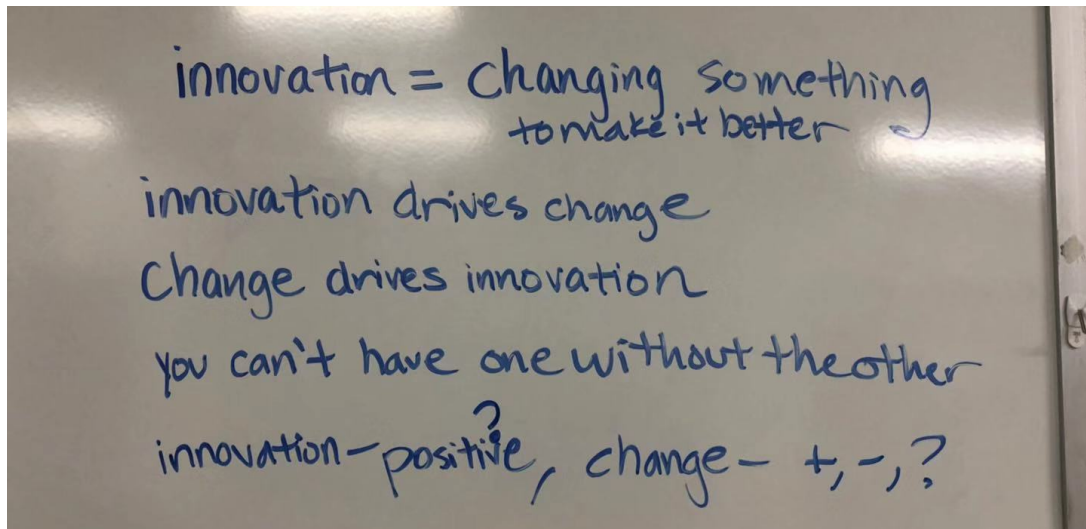
a. Formative Assessment

Several formative assessment strategies will be used throughout this unit. During the first Taba lesson, the teacher will make observational notes about students' understanding of the concept of change as they complete the Taba activity. Students will complete a one paragraph written reflection after the Taba activity, which will be used as the entry ticket into the lab activity and will provide additional assessment data.

Observations will also be made during the Bruner lesson to gauge student understanding about the roles, characteristics, tools, and traits of scientists as students grapple with understanding the discipline of science and thinking like a scientist.



The chalk talk activity will provide insights about understandings or misconceptions held by whole class. At the end of this lesson, students will develop statements about the relationship between innovation and change. After recording their ideas (which can be collected by the teacher as an additional data point) they will share their thoughts about these concepts with the class.



b. Summative Assessment

The following performance task will be presented to students as a summative assessment.

You have all just been hired as the Lead Food Science Department for a brand-new cookie company, Bull City Sweets, located here in Durham, North Carolina. This company has hired you to create the best chocolate-chip cookies in the world using an innovative new recipe. Bull City Sweets has been exploring using innovative ideas to drive change in their company, so they are asking each team to create two recipes with one distinct change between them.

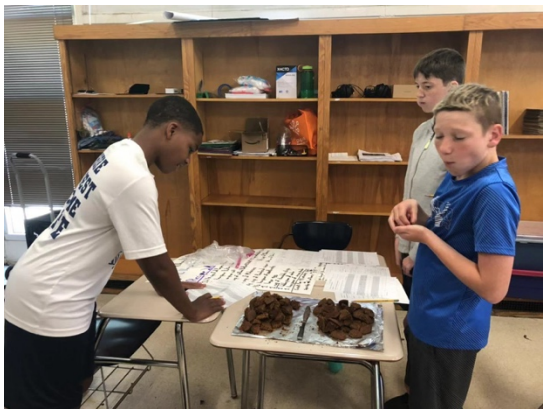
Phase 1: Each team will develop two recipes, using innovative thinking to change one variable and unlock the secret to creating the most delicious cookies possible. After developing and baking two variations of your recipe, your team will test both cookies and prepare to present them to the rest of the Food Science Department by creating an informative poster.

Phase 2: Each team will develop a rubric to score and provide feedback on all the other team's cookies. We will use these rubric scores and feedback to determine which cookie recipe is the best overall and should be used for production by Bull City Sweets.

c. Rubric for Performance Task

	Novice (0)	Apprentice (1)	Proficient (2)
Recipe Development	Recipes were not created or were incomplete. Concepts of innovation and change were not addressed.	Team created two cookie recipes but did not explain the elements of innovation or change included in their recipes.	Team successfully developed two innovative cookie recipes and can explain the element of change introduced for each recipe.
Poster	Poster was incomplete or messy. Descriptions of concepts (innovation and change) were not included or lacked depth of thought.	Poster has some information but not all necessary components. Cookie recipes are included but may be incomplete or lacking scientific detail.	Poster is informative and neat. It contains all components (recipes, descriptions, explanation of concepts of innovation and change). Both cookie recipes are included and persuasive marketing ideas are used.
Collaboration	Student shows challenges collaborating effectively with teammates on performance task.	Student shows some positive elements of collaboration, but may not consistently demonstrate these traits.	Student shows strong collaboration skills, working together with teammates to complete the performance task.

d. Examples of Performance Task Completion



IV. Lesson Plans

All lesson plans and activities for this unit are included on the following pages.

TEACHER NAME		Lesson #
Morgan Carney		1
MODEL	CONTENT AREA	GRADE LEVEL
Taba	Science	Middle School (6-8)
CONCEPTUAL LENS		LESSON TOPIC
Change		Food and Technology
LEARNING OBJECTIVES (from State/Local Curriculum)		
6.H.2.3 Explain how innovation and/or technology transformed civilizations, societies and regions over time (e.g., agricultural technology, weaponry, transportation and communication). 8.L.2 Understand how technology is used to affect living organisms. RI.8.1 Cite textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text. RI.8.5 Analyze in detail the structure of a specific paragraph in a text, including the role of particular sentences in developing and refining a key concept. L.9-10.4 Determine and/or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies: context clues, word parts, word relationships, and reference materials.		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)	THE ESSENTIAL QUESTION (What question will be asked to lead students to “uncover” the Essential Understanding)	
Innovation drives change	How does innovation drive change?	
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)	PROCESS SKILLS (What will students be able to do as a result of this lesson?)	
Students will know that • Innovation is developing a new idea, method, or product and changing what currently exists, ideally in a positive direction • Change exists in many forms all around us • Change involves things being altered or becoming different in some way • Innovative ideas can enhance, generate, inspire, and speed up change • Innovation has changed the way people eat, cook, and think about food • Development of different types of technology is an example of innovation in action • Cooking itself is an example of change • Chromatography is a type of technology that allows us to separate the various color pigments within a mixture • Chromatography involves a change from looking at one uniform color mixture to seeing unique, individual pigments	Students will be able to • Collaborate with a group • Analyze ideas from a text • Classify and defend relationships between ideas • Synthesize knowledge • Execute an experiment • Explain • Make inferences	

GUIDING QUESTIONS			
What questions will be asked to support instruction?			
Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding			
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:	
• What did you notice about the questions on the bingo cards? What are some similarities between the questions? • How do these BINGO card questions relate to change? • What are examples of change that can be found in the song “Changes” by John Mayer? • What are examples of change in the world? • Why do things change? • What does “change” mean to you? • How is cooking an example of change? • What is innovation? • How are innovation and change different? • How are innovation and change the same? • How does innovation drive change?	• What are examples of change in this article? • How can you group these examples of change into unique categories? • What do the items in this group have in common? • What is the same about this group and this other group? • What is different about the two groups? • Which examples could be subsumed under another label? • How could some of your categories be subsumed under any other groups? • What is another way that you can organize and categorize these examples of change? • What generalizations can you make about change • What generalizations or statements can you make about the relationship between change and innovation? • “What do you mean by that relationship? • What is another way you could state that relationship? • What is an example of that relationship between innovation and change?” • How has innovation changed the foods that we eat? • How has innovation changed the way we cook? • Why is change important? • Why is innovation important? • How are change and innovation connected?	• What new ideas, thoughts, or questions do you have about change? • What new ideas, thoughts, or questions do you have about innovation? • In what ways can change be beneficial, and in what ways can change be harmful? • In what ways can innovation be beneficial, and in what ways can innovation be harmful? • Which generalization on the board stands out to you as most accurate or important? • How is chromatography an example of change? • How is chromatography an example of innovation? • How are change and innovation connected? • How does innovation drive change?	
DIFFERENTIATION			
Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.			
Content	Process	Product	Learning Environment
The text used in this activity was written for an older audience. The vocabulary in the article is advanced and the content is deeper than students’ grade-level.	Students will dig into the concept of change through the Taba model of sorting, naming, regrouping, subsuming, and generalizing.		

PLANNED LEARNING EXPERIENCES

Introduction - As students come in, they will sit in a circle for introductions. The teacher will start by asking each student to say their name and one thing they like that starts with the same letter of their name. (For example, "My name is Max and I like mangoes.") Then each student will be given a copy of the BINGO Introduction game. Students will walk around the room introducing themselves to each other and finding other students who can sign in each box of their BINGO card. After the activity, the teacher will ask, "What did you notice about the questions on the bingo card? What are some similarities between the questions? How do these questions relate to change?" (20 minutes)

Engage and Connect - *This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.*

Students will listen to the song "Changing" by John Mayer. https://www.youtube.com/watch?v=AOQ_J0T1qpk As a class, we will read the lyrics and discuss examples of change that can be found in this song. We will have a class conversation around these questions: What are examples of change that can be found in this song? What are other examples of change in the world? Why do things change? What does "change" mean to you? What is innovation? How are innovation and change different? How are innovation and change the same? How does innovation drive change? (15 minutes)

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

List: Students will read the article "How Technology Is Changing What We Eat", which discusses a wide variety of ways in which technology has altered what foods we eat, how we think about food, and how we cook. As students read, they will underline words and/or phrases that relate to some aspect of change. (Students will be asked, "What words/phrases/ideas do you notice that have to do with change? As you read, underline or highlight any words or phrases that are related to change in some way.") After the students have made their individual lists, they will share ideas with the class and the teacher will record all the examples of change on the board. (25 minutes)

SNACK BREAK (15 minutes)

Explain - *Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.*

Group: Students will be placed into groups of three and each group will be given twenty small sticky notes. The groups will work together to pick twenty examples of change from the class list on the board and write one example on each sticky note. Next, students will work together to put the sticky notes into groups that have something in common. (How can you group these examples of change into unique categories?) Students will be reminded of three expectations: 1) They must use all twenty words and the words can only be in one group each. 2) Each group must contain at least three words. 3) They must create at least four different groups.

Label: Once a team of students has finished grouping their sticky notes, the teacher will ask them to label each group and explain why those items were grouped together. Questions for teacher to ask to prompt group discussions: What do the items in this group have in common? What is the same about this group and this other group? What is different about the two groups? (20 minutes)

Elaborate - *Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways.*

Subsume, regroup, rename: Each student team will be asked if they could subsume any of their groups within another group they have created. Next, student teams will be asked to regroup their sticky notes into completely new categories. The expectations are as follows: 1) They must use all twenty words, but this time the words may be used in more than one group each. 2) Each group must contain at least three words. 3) They must create at least three different groups. Questions for teacher to ask to prompt small group discussions: Which examples could be subsumed under another label? How could some of your categories be subsumed under any other groups? What is another way that you can organize and categorize these examples of change? After groups have finished the subsuming, regrouping, and renaming process, each student team will be asked to share their categories, along with one or two examples of the sticky notes they put in each category. (15 minutes)

Generalize: Each student will be given a post it note. The teacher will ask, "What is one generalization about change that you can make after completing this activity? Write your generalization down on your post it note. Next, the teacher will lead students to share their generalizations and discuss the question, "What generalizations can you make about change?" Next, the teacher will ask, "What generalizations or statements can you make about the relationship between change and innovation?" As students share, teacher will make a list of these generalizing statements on the board and ask probing questions for students to dig deeper. "What do you mean by that relationship? What is another way you could state that relationship? What is an example of that relationship between innovation and change?" (15 minutes)

Evaluate - *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

Next, the class will have a full group discussion around the questions: How has innovation changed the foods that we eat? How has innovation changed the way we cook? Why is change important? Why is innovation important? How are change and innovation connected? What new ideas, thoughts, or questions do you have about change? What new ideas, thoughts, or questions do you have about innovation? In what ways can change be beneficial, and in what ways can change be harmful? In what ways can innovation be beneficial, and in what ways can innovation be harmful? (15 minutes)

Reflection: Students will be asked, "Which generalization on the board stands out to you as most accurate or important?" Students will choose one of the generalizations on the board (it could be one they shared or one that a classmate shared) about the relationship between innovation and change. They will each write a one paragraph reflection about their thoughts on change and innovation and why the statement/relationship they choose is best statement of the generalizations listed on the board. These writing samples will serve as entry tickets for the students to complete the lab for the remainder of the period. (15 minutes)

Extend (Lab) - Students will conduct a candy chromatography lab to observe the changes that happen over time. Students will be put into pairs and each pair will start by conducting a paper chromatography test with black markers. Students will then use colored M&Ms and Skittles to complete chromatography tests. We will explore how the simple technology of chromatography creates a change by separating out the various colored pigments used in everything from markers to candy. After conducting the lab, we will have a group discussion centered around the question, "How is chromatography an example of change? How is chromatography an example of innovation? How are change and innovation connected? How does innovation drive change?" (40 minutes) <https://learning-center.homesciencetools.com/article/candy-chromatography-science-project/>

<https://www.psychologytoday.com/us/blog/the-why-behind-the-buy/201204/how-technology-is-changing-what-we-eat>

How Technology Is Changing What We Eat

Technology's notable impact on how and what we eat

Posted Apr 01, 2012

Kit Yarrow Ph.D.

If you're old enough to have watched "The Jetson's," the first moon landing or "Lost in Space" you've always known that technology would impact what you ate for dinner. Maybe you imagined that kitchen clean-up problems would be solved by tidy meal pills or space pouch food, or that ovens would be replaced by ray-guns that could cook a golden-brown turkey in seconds.

Fast forward to 2012 and technology has indeed had a notable impact on how and what we eat. Not because it's changed the way we cook, but more because it's changed who we are, how we think, and opened up, literally, a world of options.

Depending on how old you are and how much you use technology, you may have noticed some of these commonly documented side effects of our increasingly wired lives:

- We get bored more easily, the bar is higher when it comes to stimulation
- The world seems smaller. Foreign isn't foreign anymore
- We're more open to trying new things. With every new version of our computer or cell phone we have a crystalized belief that "new is better"
- We're better at multi-tasking. In fact, we can't help but multi task because we get distracted more easily and we're more impatient
- We're more self-reliant and resourceful when it comes to finding information

Preparing and eating food is one of the most fundamental activities of humanity. It's only natural that we'll see changes in our psychology reflected how we choose to shop and cook, and what we want to eat. Here are some examples of how technology has shaped our food preferences and the innovative ways the food industry is responding.

McCormick, the leading spice company in the country has recently launched an advertising campaign touting the multi-tasking capabilities of its products. From the antioxidant capabilities of oregano and pepper, to brain-saving turmeric - adding a pinch of good health along with flavor appeals to the multi-tasker in all of us. The success of products ranging from Vitamin Water to probiotic jalapeno dip is a testament to our love of innovation and our expectation that everyone and everything can and should do more than one thing at a time.

Turmeric, by the way, will one of the top food trends of 2012. The vivid yellow spice commonly used in Thai, Indian and Persian dishes also gets a boost in appeal from our craving for more variety and global flavors. Twenty-five years ago, ravioli, tacos and egg rolls were ethnic dining. There's very little that's considered "foreign" today, in part because of our hyper-connected world.

We're also craving more intensity and stimulation from our food. Witness the success of Domino's jalapeno "The Revenge" pizza, Firey Pepper Southern Comfort, chili and bacon chocolate, black pepper ice cream and mango mint gum - clearly the bar for stimulation and sensation has been raised.

There's a double-edged sword to all these options, namely the anxiety of wondering if we should have picked something better and the mental overload of constantly making ever more complicated decisions.

To give ourselves a mental break we're making purchasing decisions in different ways. For one, we speed up the process by relying more on visual and symbolic communication and less on explanations and verbal information. Things like a brand's association with other brands, what others are saying about a product, event sponsorship and sampling have more impact than company-driven messaging. Our perception of products seeps into consciousness through multiple flashes of information from a wide variety of sources rather than through actively and purposefully thinking through a product's characteristics.

For example, the astounding growth and success of San Francisco start-up Popchips has a lot to do with how the company promoted the product. It's precisely in line with the way that our techno-fueled brains process information. Consumers' positive perception of Popchips was acquired through multiple channels: association with trusted distribution outlets like Jamba Juice, Virgin Airlines, Costco and Whole Foods; buzz generated from fans like Ashton Kutcher and Sarah Jessica Parker; a massive giveaway program; advertising; and a strong social media campaign. Granted, Popchips are great chips, but lots of terrific products have failed - especially in the crowded snack food category. Popchips' messaging was key to its success.

Innovation cycles much more quickly than ever before. While it may be inspired by our craving for stimulation, it's fueled by online resources, food programs and videos. Ever more resourceful and self-reliant consumers use information from trusted blogs, tweets, promotions and online reviews for ideas, inspiration and the reassurance to try new things. Fully 65% of women are a friend or fan of a brand on Facebook. McKinsey research has found that $\frac{2}{3}$ of what shoppers learn about products today is driven by the consumer, not the seller. This moves new products more quickly into mainstream usage.

With all this time spent online (and more complicated lives) we're increasingly bereft of the time and mental focus required to cook and shop the way we did a decade ago. Besides, things like washing, boning and peeling are more boring to our speed demon brains. To the rescue are kits for everything from salads to pot roast.

Kits also satisfy the "I want what I want when I want it" side effect of technology. Today, anytime, anywhere convenience is key. Part of McDonald's strong earnings are the result of their fastest growing time segment which is from midnight to 5:00 AM. Now available in France, and no doubt soon to arrive in the US, are 24-hour baguette vending machines that finish off a par-baked loaf on command. In Japan you can shop at a virtual grocery store in your train station and have your selections waiting for you when you arrive at your destination.

From a consumer psychologist's perspective, we really are what we eat. Technology isn't the only socio-cultural factor that's influenced food trends. The economy, demographic shifts and environmentalism have also impacted what we want and how we shop and eat. Consumer psychology is most known as the secret sauce of successful marketing - but it's also a window into the shifting needs, desires and motivations of societies.

BINGO

Someone who learned a new dance move in the past 3 months.	Someone who got a haircut in the past two months.	Someone who tried a new sport in the past school year. What sport? _____	Free Space!	Someone who has changed the color of their hair or fingernails in the past year.
Free Space!	Someone who has read a new book this summer. Name of book: _____	Someone who is learning how to play an instrument. What instrument? _____	Someone who has grown at least two inches in the past 6 months.	Someone who recently discovered a new song that they like. Name of song: _____
Someone who saw a new movie this summer.	Someone who moved in the past three years.	Free Space!	Someone who traveled somewhere new in the past three months.	Someone who is learning a new language. What language? _____
Someone who recently discovered a new game that they like. Name of game: _____	Someone who learned how to do something new on the computer in the past two months.	Someone who switched schools in the past two years.	Someone who got a new pet within the past two years. Name of pet: _____	Free Space!
Someone who has been to a new restaurant in the past year. Name of restaurant: _____	Free Space!	Someone who made a new friend in the past month.	Someone who recently discovered a new food that they like. Name of food: _____	Someone who lost a tooth or got braces in the past year.

LAB ACTIVITY

Name: _____ Date: _____ Period: _____

Title: Candy Chromatography

Question or Problem: How can we use innovation and change to separate color pigments?

Vocabulary:

Innovation- _____

Change- _____

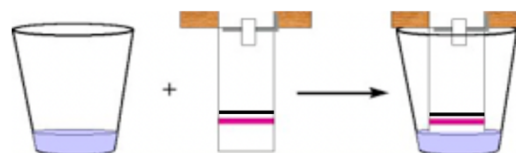
Chromatography- _____

Materials (per partner group):

- Scissors
- Rulers
- Coffee filter paper
- Tin foil
- Tape
- Pencils
- Plastic cups
- Water
- Various black markers
- Skittles, M&Ms and other colorful candies

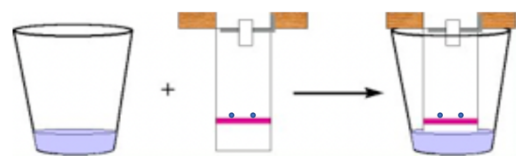
Procedure: Marker Strips

1. Make your filter paper strips from the coffee filter paper. Measure two rectangles that are 2 cm by 8 cm. Carefully cut out the rectangles.
2. Use a pencil to draw a line on the paper about one cm from the bottom. Using the pencil, label each strip with the type of black marker. Then draw a thin line of marker right above the pencil line.



Procedure: Candy Strips

1. Make your filter paper strips from the coffee filter paper. Measure seven rectangles that are 4 cm by 8 cm. Carefully cut rectangles.
2. Use a pencil to draw a line on the paper about one cm from the bottom. Draw two small pencil dots right above the line. Repeat for each filter paper rectangle.
3. Next, start removing the dye from your candies. Cut out two small (about 2 cm X 2 cm) pieces of foil. Place a green M&M on one piece of foil and a green Skittle on the other piece of foil. Place three drops of water on each candy and let sit. Repeat for each color candy. Wait until the candy color soaks into water.
4. Label one pencil dot on a filter strip “green M&M” and the other “green Skittle”. Dip a toothpick into the tiny pool of green M&M dye. Touch it just above the labeled pencil dot on the filter strip. Let the tiny dot dry. This should only take a minute. Repeat dabbing a dot in the exact same place with the same candy’s dye on the filter paper, and then letting it dry, at least six times. Your chromatography results will be much better if you have thick, tiny dots of each color.



Procedure: Set up Chromatography

1. Tape the top of each coffee filter strip to a pencil and balance the pencil across the top of the cup. Adjust so that the paper hangs straight down and stops just above the bottom of the cup.
2. Remove the paper and add a small amount of water to the bottom of the cup. Place the strip/pencil back into the cup. **It is very important that the water in the cup is BELOW the pencil line!**
3. Set the cup aside. The water will move up the filter paper slowly and separate the pigment components.
4. Repeat for each filter strip.

Data and Observations: Record your observations below.

Black Marker #1: _____	Black Marker #2: _____
Red M&M	Red Skittle
Orange M&M	Orange Skittle
Yellow M&M	Yellow Skittle
Green M&M	Green Skittle
Blue M&M	Purple Skittle
Brown M&M	Other: _____
Other: _____	Other: _____

Reflection Questions:

- 1) How do scientists use innovation?
- 2) What were some examples of change in this lab?
- 3) How does innovation drive change?

Name: _____ Date: _____

“Changing” by John Mayer

[Chorus]

I am not done changing
Out on the run, changing
I may be old and I may be young
But I am not done changing

[Verse]

I met me someone changing
We had some fun changing
Sometimes I wonder if she'll be the one
When I am done changing

Some of us stopped running
Some of us went home
Some of us don't got one
So we'll build one of our own

Friends behind their fences
Looking at me strange
Wondering when I'm gonna come to my senses
But I'm still changing
And I can't change my ways

I see the sky changing
Reminds me of my changing
Wish I could tie me a rope 'round the sun
'Cause I am not done changing

[Bridge]

Time's been talking to me
Whispering in my ear
Saying “Follow your heart
'Til it tears you apart”
But hearts keep changing
Hearts keep changing
Hearts keep changing
Hearts keep changing

[Instrumental Solo]

[Chorus]

I am not done changing
Out on the run, changing
I may be old and I may be young
But I am not done changing
Changing
Changing

TEACHER NAME		Lesson #
Morgan Carney		2
MODEL	CONTENT AREA	GRADE LEVEL
Bruner	Science	Middle School (6-8)
CONCEPTUAL LENS		LESSON TOPIC
Change		Characteristics of a Scientist and Scientific Experimentation- Dippin' Dots
LEARNING OBJECTIVES (from State/Local Curriculum)		
Social Studies 6.H.2.3 Explain how innovation and/or technology transformed civilizations, societies and regions over time. ELA W.8.1 Write claims about topics or texts. Science 8.L.2 Understand how technology is used to affect living organisms. Science 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. (connected to the lab) Science Chm.2.2.2 Analyze the evidence of chemical change (connected to the lab)		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to "uncover" the Essential Understanding)
Innovation drives change		How does innovation drive change?
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)
Students will know that • Scientists constantly use innovation to drive change • Scientists use structured research and innovative techniques and ideas to drive change • There are many different types of scientists and science • Change exists in many forms all around us • Change involves things being altered or becoming different in some way • Liquid nitrogen is nitrogen in a liquid state at an extremely low temperature • Liquid nitrogen allows things to be frozen quickly • Liquid nitrogen is an example of innovation • Innovation (such as innovative ideas and techniques) drives change		Students will be able to • Analyze characteristics • Compare and categorize ideas • Discuss and defend their ideas • Safely follow procedures • Summarize • Explain • Draw conclusions

GUIDING QUESTIONS

What questions will be asked to support instruction?

Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding

Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:
• What do you notice? • What is going on in these images? • What do you see that makes you say that? • What else can you find? • What else do you notice? • What do these images have in common? • What else do you notice? • What examples of change do you see in these images? • What examples of innovation do you see in these images? • As a scientist, what else might you notice about these images? • What scientific questions do you have about these images?	• What do you know about scientists? • What do scientists do? • What do scientists wear? • What tools do scientists use? • Where do scientists work? • What are characteristics or traits that scientists should possess? • What is the role of a scientist? • What else would you add to our lists about scientists? • What different types of scientists did you see in this video? • What methods did the various scientists in the film use? • What kinds of data did the scientists record? • What information was important to these scientists? • What tools did these scientists use? • What characteristics did these scientists have? • What traits would be most important for these scientists? • What examples of change did you see in this video? • What examples of innovation did you see in this video? • Why should scientists be innovative? • Why might scientists strive to create change? • What types of change should scientists pursue? • What examples of scientific innovation can you think of? • What other ‘types’ of scientists exist? • What do these other scientists do? • How do they act? • What tools do they use? • Where do they work? • What characteristics do they possess? • How do other scientists use innovation? • How do other scientists create change? • How are scientists also innovators? • How do scientists develop new ideas? • How do new ideas create change? • How does innovation enhance change? • If you could only use six words, how would you describe scientists and science? • How do scientists use innovation to drive change? • Who has heard of liquid nitrogen? • What do you know about liquid nitrogen? • What are some uses of liquid nitrogen? • How can liquid nitrogen create change? • How can liquid nitrogen create innovation? • What safety concerns do we need to be aware of when using liquid nitrogen? • Why is safety important in science? • Why are set procedures important in an experiment?	• What is liquid nitrogen? • How do scientists use innovation? • What were some examples of change in this lab? • How has our ice cream changed? • How is this ice cream we created different than ice cream you buy at the store? • What elements of innovation did we use to transform this ice cream? • How does innovation drive change? • What changes occurred during this lab? • What did you notice while completing this lab? • What was interesting, surprising, or unexpected? • In what ways were you able to be a scientist in this lab? • What actions, characteristics, skills, or habits of a scientist did you display? • What tools and resources of a scientist did you use? • What else did you learn about scientists and science from completing this lab the way a scientist would complete a lab? • How do scientists use innovation to drive change? • What do you now know about innovation and change? • How does liquid nitrogen represent innovation and change? • How does innovation drive change?

DIFFERENTIATION			
Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.			
Content	Process	Product	Learning Environment
Students will be asked to consider the role of a scientists in a multidimensional way, incorporating several examples and their prior knowledge. Students will be able to make unique connections between various forms of science that seem different but are interconnected.	This lesson requires students to investigate the concepts as a professional scientist.		

PLANNED LEARNING EXPERIENCES
Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students. As students come into the room, the slideshow of images (Bruner Lesson Hook) will be displayed on the projector. Students will be asked, "What do you notice? What is going on in these images? What do you see that makes you say that? What else can you find? What else do you notice? What do these images have in common? What else do you notice?" Students will write their ideas down on an index card. After an open class discussion sharing the ideas they have written down, students will be guided toward the main concepts and ideas of the lesson with the question, "What examples of change do you see in these images? What examples of innovation do you see in these images? As a scientist, what else might you notice about these images? What scientific questions do you have about these images?" (10 minutes) ***** Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas. At the start of class, students will be instructed to create individual lists of what they know about scientists. The teacher will ask, "What do you know about scientists? Write down every idea you have about scientists on your paper." (5 minutes) After students have made their lists, we will have a full group chalk talk. The three protocols for a chalk talk are 1) say yes, 2) step up and step back, and 3) no talking. The teacher will write the word "Scientists" on the board, then students will use white board markers to list as many ideas about scientists as they can collectively think of. (15 minutes) Next, we will take these ideas that students have developed both individually and as a group to answer several questions and make new lists as a class on the board. The teacher will first ask, "What do scientists do?" and the class will help make a list. Next, the teacher will ask, "What do scientists wear? What tools do scientists use? Where do scientists work? What are characteristics or traits that scientists should possess?" After each question, ideas will be written on the board. (15 minutes) The teacher will introduce the video, "A Day in the Life of a Food Scientist" https://www.youtube.com/watch?v=4wAC-ST77Ow Students will be instructed to think about the question "What is the role of a scientist?" as they watch the video. They should focus on what the scientists do, how they act, what tools they use, where they work, and the characteristics they possess. (5 minutes) ***** Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding. After the video, students will work with a partner to add new ideas to their original lists about scientists. The teacher will ask, "What else would you add to this list? What different types of scientists did you see in this video? What methods did the various scientists in the film use? What kinds of data did the scientists record? What information was important to these scientists? What tools did these scientists use? What characteristics did these scientists have? What traits would be most important for these scientists?" Next, the teacher will ask, "What examples of change did you see in this video? What examples of innovation did you see in this video? Why should scientists be innovative? Why might scientists strive to create change? What types of change should scientists pursue? What examples of scientific innovation can you think of?" After adding ideas to their lists with a partner, the teacher will ask students to share ideas and will update the class lists on the board. This is an interesting video because students will learn about a NASA food scientist, but will also be primed to think about astronauts as scientists. The teacher should encourage students to think about science and scientists from multiple angles. In light of this, the teacher may then ask, "What other 'types' of scientists exist? What do these other scientists do? How do they act? What tools do they use? Where do they work? What characteristics do they possess? How do other scientists use innovation? How do other scientists create change?" and prompt students to think about botanists, zoologists, chefs, engineers, and more. While these conversations occur, the teacher will record students' ideas on the board and add to the class list. Students will be guided to think about elements of innovation and change throughout this conversation. The teacher will ask, "How are scientists also innovators? How do scientists develop new ideas? How do new ideas create change? How does innovation enhance change?" (25 minutes) SNACK BREAK (15 minutes) 1h 40m *****

Elaborate - Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways.

Teacher will say, “We are about to think like scientists. Specifically, we are going to think like NASA food scientists, and we are going to think about how innovation drives change. Who has heard of liquid nitrogen? What do you know about liquid nitrogen? What are some uses of liquid nitrogen? How can liquid nitrogen create change? How can liquid nitrogen create innovation? What safety concerns do we need to be aware of when using liquid nitrogen?” (5 minutes)

Students will be divided into groups of three to complete the Dippin’ Dots Lab attached to this lesson plan. Each student will be assigned a role for the lab: Supply Management, Procedure Management, Data and Observations Recorder. Students will focus on these different roles of a scientist as they complete the lab. The teacher will go over necessary safety instructions and ask students, “Why is safety important in science?” Next, the class will read over the procedure and discuss the question, “Why are set procedures important in an experiment? (replication of results, safety, etc.)” Students will follow the procedures outlined on the lab sheet to complete the lab as a team of scientists in their various roles. (All use of liquid nitrogen will happen at one station, supervised by the teacher.) After the lab is finished and the room is clean, students will be able to taste their homemade “ice cream of the future”! (40 minutes)

Evaluate - This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.

When they are done with the active portion of the lab, all students will individual answer the reflection questions on the lab template: What is liquid nitrogen? How do scientists use innovation? What were some examples of change in this lab? How has our ice cream changed? How is this ice cream we created different than ice cream you buy at the store? What elements of innovation did we use to transform this ice cream? How does liquid nitrogen represent innovation and change? How does innovation drive change?

The class will then come together as a full group and the teacher will ask the question, “What changes occurred during this lab?” The class will make a list on the board of all the changes that occurred during this lab. (10 minutes)

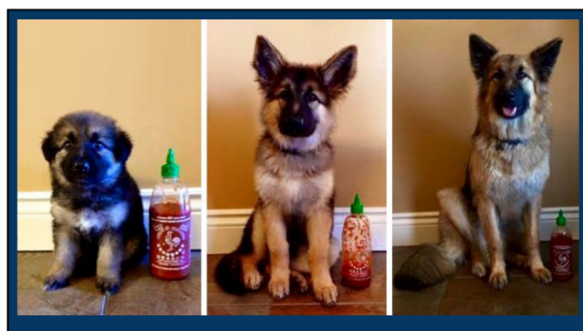
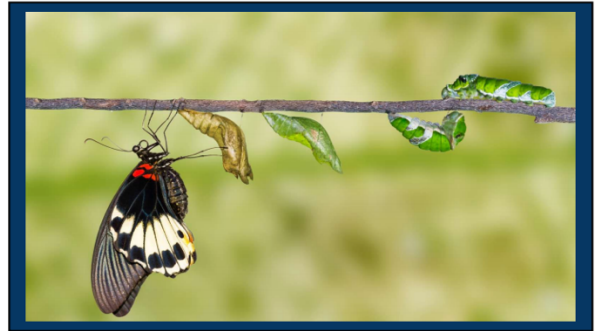
The teacher will then ask the full class the following discussion questions. “What did you notice while completing this lab? What was interesting, surprising, or unexpected? In what ways were you able to be a scientist in this lab? What actions, characteristics, skills, or habits of a scientist did you display? What tools and resources of a scientist did you use? What else did you learn about scientists and science from completing this lab the way a scientist would complete a lab? How do scientists use innovation to drive change? What did you learn about innovation and change? How does innovation drive change?” The class will add new ideas to their list on the board. (15 minutes)

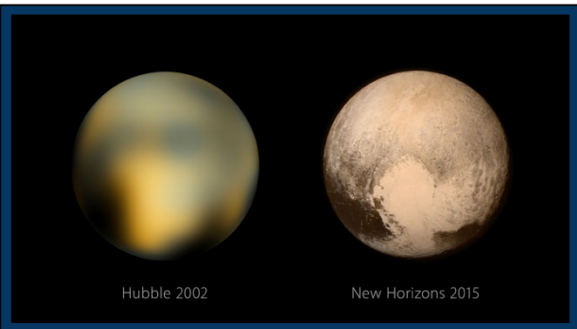
After this lab, students will be instructed to write “six-word poems” about scientists and science. “If you could only use six words, how would you describe scientists and science? How do scientists use innovation to drive change?” Each student will be given an index card to write a draft of their six-word poem. Their poem should convey what they think is most important about scientists and science, in only six words! Once students have written their poems, they will share them out to the class. (20 minutes)

At the of the class, students will be given an index card. They will be asked to write down one new thing they learned about change and innovation and one new question they have as an exit ticket before they leave. (5 minutes)

BRUNER LESSON HOOK

https://docs.google.com/presentation/d/1qRW9ebhtR1UMj42nu_jpu70Oh3FxknCBbI4Skpisk7g/edit?usp=sharing





LAB ACTIVITY

Name: _____ Date: _____ Period: _____

Title: Ice Cream of the Future

Question or Problem: How can we use innovative technology to make spherical ice cream dots of the future, instead of regular ice cream?

Vocabulary:

Innovation- _____

Change- _____

Liquid nitrogen- _____

Spherification- _____

Materials (per group of three):

- 1 cup heavy cream
- 1/2 cup half and half
- 1/2 teaspoon vanilla extract
- 1/3 cup sugar
- Food coloring
- One large mixing bowl
- One large mixing spoon
- Three small paper Dixie cups- one per student
- Three styrofoam bowls- one per student
- Three small plastic spoons
- Three droppers
- Liquid nitrogen

Procedure: Preparation

3. Make sure you have all necessary materials. Each student should use a marker to write their name in a visible spot on their Dixie cup and their styrofoam bowl.
4. As a group, in the large mixing bowl, measure out the correct amount of heavy cream, half and half, vanilla extract, and sugar. Mix them together and stir well so that the sugar completely dissolves in the liquid.
5. Carefully divide the liquid mixture into the three Dixie cups.
6. Each student can add up to three drops of food coloring of their choice the liquid ice cream mixture in their personal Dixie cup. Mix food coloring in well.

Procedure: Freezing Station

1. Once your liquid ice cream base is ready, your group will be called over to the freezing station. The teacher will carefully pour a small amount of liquid nitrogen into each student's styrofoam bowl. **DO NOT TOUCH THE LIQUID NITROGEN!**
2. Using the dropper, drip small amounts of your ice cream mixture into the bowl of liquid nitrogen. Do not go too fast; if you do, your dots will stick together!
3. When you are done, place your bowl on the finishing table. Your ice cream is too cold to eat and actually needs to warm up for a little while. All the liquid nitrogen will finish evaporating from your bowl, if it has not already evaporated. In the meantime, answer the questions below.
4. Once the teacher tells you your ice cream has warmed up enough and is ready, you may get your ice cream bowl, eat, and enjoy!

Observations: What did you notice while completing the lab?

Reflection Questions:

- 4) What is liquid nitrogen?
- 5) How do scientists use innovation?
- 6) What were some examples of change in this lab?
- 7) How does liquid nitrogen represent innovation and change?
- 8) How does innovation drive change?

TEACHER NAME		Lesson #
Morgan Carney		3
MODEL	CONTENT AREA	GRADE LEVEL
Questioning	Science	Middle School (6-8)
CONCEPTUAL LENS		LESSON TOPIC
Change		Mystery Materials
LEARNING OBJECTIVES (from State/Local Curriculum)		
Writing 9-10.5 Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. Science 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. Science Chm.2.2.2 Analyze the evidence of chemical change. Science 8.L.2 Understand how technology is used to affect living organisms. Reading 7.3 Analyze the interactions between individuals, events, and ideas. Speaking & Listening 9-10.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to "uncover" the Essential Understanding)
Innovation drives change		How does innovation drive change?
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)
Students will know that - Baking is a form of science - Different substances/ingredients (flour, sugar, salt, baking powder, baking soda) have different properties (solubility, flammability, etc.) - Scientists use both observations and physical and chemical testing to learn more about materials - Scientists collaborate with team members to make predictions and test hypotheses		Students will be able to - Develop and ask questions - Discuss ideas - Conduct research - Collaborate with a team - Follow directions - Compare and contrast - Solve a problem - Analyze - Apply information to new situations

GUIDING QUESTIONS			
What questions will be asked to support instruction?			
Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding			
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:	
• Why should the boy give the mouse a cookie? • Why should the boy not give the mouse a cookie? • Why is it important if the boy gives the mouse a cookie? • What difference will it make if the boy chooses to give the mouse a cookie? • Why do you think the boy choose to give the mouse a cookie? • Why do you think the mouse was asking for the cookie? • What is your opinion of the mouse and his actions? • What is your opinion of the boy and his actions? • If a mouse actually showed up and asked you for a cookie, what would you do? • What would convince you to give the mouse the cookie? • What would convince you not to give the mouse the cookie? • What if it was a person who asked you for a cookie; what would you do and why? • What if it was a small child? • What elements of change did you notice in this story? • What elements of innovation did you notice in this story? • How were innovation and change connected in this story? • Our ingredients are all mixed up, what are we going to do? • How are we going to bake our cookies? • How will we know which ingredient is which?	<i>**All the questions from the chart under the Explore section of the lesson plan**</i> • What did your team discover about each substance? • Which bowl contains which ingredient? • What different tests did you complete? • What observations did you make? • How did innovation play a role as you determined each ingredient? • What was the most challenging part of conducting your research? • How were you using the habits and skills of a scientist during this activity? • How do scientists use innovation? • Why do scientists always look for examples of change? • What other connections can you make to change from this experience? • What connections can you make to innovation? • What new ideas do you have about change and innovation? • How are change and innovation connected? • How does innovation drive change?	• What two recipes will your team use? • Which variable will you change between your two recipes? • Why did you choose that variable to alter? • What predictions can you make about how your two cookie recipes will be different? • How will changing that one variable in your team’s recipe will change your cookies? • If you could change two variables, what other element would you like to test? • What variable would you change if you were making pancakes instead of cookies? • What variable would you change if you were making cake instead of cookies? • How is testing these two recipes an example of change? • How is testing these two recipes and example of innovation? • What other types of innovative techniques could chefs use to make cookies? • What are three connections to or examples of change that you found interesting today? • What are two new things you discovered about innovation? • How are change and innovation related?	
DIFFERENTIATION			
Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.			
Content	Process	Product	Learning Environment
Students will learn about chemical reactions and research physical and chemical changes at the level of a food scientist.	Students will be grappling with questions primarily from the top levels of Costa’s Levels of Inquiry and Bloom’s Taxonomy. Additionally, student teams will develop their own questions to investigate using the skills and techniques of scientists.		

PLANNED LEARNING EXPERIENCES
Engage and Connect - This phase focuses on piquing students’ interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students. Before the class starts have six bowls-- one bowl each of flour, sugar, salt, baking soda, baking powder, and powdered sugar-- on the table with easy to pull off labels. Label the bottom of each bowl with a letter code so that you know which one is which. The teacher will welcome the students and tell them that they are going to make the batter for their two different cookie recipes today. The teacher will show the class the bowls of ingredients on the side table. “We have all the ingredients here that we need to make delicious cookies for our new bakery. But before we get started on our baking project, I want to read you one of my favorite books.” The teacher reads “If You Give a Mouse a Cookie”, then asks the class the following pre-lesson questions: “Why should the boy give the mouse a cookie? Why should the boy not give the mouse a cookie? Why is it important if the boy gives the mouse a cookie? What difference will it make if the boy chooses to give the mouse a cookie? Why do you think the boy choose to give the mouse a cookie?”

Why do you think the mouse was asking for the cookie? What is your opinion of the mouse and his actions? What is your opinion of the boy and his actions? If a mouse actually showed up and asked you for a cookie, what would you do? What would convince you to give the mouse the cookie? What would convince you not to give the mouse the cookie? What if it was a person who asked you for a cookie; what would you do and why? What if it was a small child? What elements of change did you notice in this story? What elements of innovation did you notice in this story? How were innovation and change connected in this story?" (15 minutes)

As the class discussion is ending, a "bandit" will rush into the classroom playing crazy music. (Have the teacher give a sneaky signal to someone in the hall when the discussion is winding down so they know when to come into the room.) The bandit will take the labels off of the bowls and mix the bowls around so students don't know which bowl is which. The teacher will exclaim things like, "OH NO! Our ingredients are all mixed up, what are we going to do? How are we going to bake our cookies? How will we know which ingredient is which?" (5 minutes)

Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.

There are six bowls on the counter containing flour, baking soda, baking powder, salt, white sugar, and powdered sugar, but the students do not know which bowl is which. Students will be divided into their teams (three to four students) and will be tasked with figuring out which substance is which. *Note: THEY MAY NOT INDEPENDENTLY TASTE ANY SUBSTANCES. This is a science lab. It is not safe to eat materials in a scientific setting without very clear procedures and safety precautions. Students will be allowed to taste the substances as a whole class activity at the very end if they desire, but will have to rely on other senses and scientific testing to determine which substance is which before then. The teacher should clearly explain this to students ahead of time.

In their teams, students will come up with a list of questions and ways they want to both observe and test their substances. All testing must be approved by the teacher before it is executed. Teams may do research to come up with ideas for how to test the substances. The teacher will guide and prompt students in their investigations using the following list, as well as any additional questions that students develop. Teams will record all their observations and take notes about the substances in a graphic organizer as they complete their testing. (60 minutes)

Level 1A: Knowledge How would you describe each substance? Which substances are opaque and which are translucent? What physical state is each substance in?	Level 1B: Comprehension What do baking soda and baking powder have in common? What do salt and sugar have in common? What are some of the chemical and physical properties of each of these substances?
Level 2A: Application How would you use each of these substances in cooking? How might a scientist use each of these substances? What other ways can you test these substances? What is the pH of each substance? What is the solubility of each substance? What is the flammability of each substance? How is baking soda used in a cookie recipe? How is baking powder used in a cookie recipe? How is flour used in a cookie recipe? How is sugar used in a cookie recipe? How is salt used in a cookie recipe?	Level 2B: Analysis What different tests could be conducted to determine substances? What evidence can you find to show which substance is which? How are these substances related to each other? How are these substances similar and different from each other? How would you classify these substances into groups? What inferences can you make about these substances? How can you make a distinction between types of these substances? What happens if you apply heat to each of these substances? What happens if you mix each substance with water? What happens if you mix each substance with vinegar? What happens if you mix each substance with water?
Level 3A: Synthesis How could you determine which substance is which with testing? How could you determine which substance is which w/ observation? How could you develop a series of tests to identify each substance? How could you create a flow chart showing various properties of each substance to distinguish one from another? What recommendations would you give a baker or scientist who mixed up their ingredients? How would you rate the flammability of each substance? How would you rate the solubility of each substance in water? How would you rate the solubility of each substance in vinegar? How would you prove whether a bowl contains salt or sugar? How would you prove whether a bowl contains baking soda, baking powder, or flour? How do these scientific tests connect to the concept of change? How do these scientific tests connect to the concept of innovation?	Level 3B: Evaluation When would it be better to use baking soda instead of baking powder in a recipe? When would it be better to use b. powder instead of baking soda? Why would you select baking soda versus baking powder for a cookie recipe? Why would you select baking soda versus baking powder for a cake recipe? Why would you select baking soda versus baking powder for a pancake recipe? Based on what you know, why is flour included in a cookie recipe? Based on what you know, why is sugar included in a cookie recipe? Based on what you know, why is salt included in a cookie recipe? Based on what you know, why is baking powder included in a recipe? Based on what you know, why is baking soda included in a recipe? Based on what you know, which mystery substance is which?

SNACK BREAK (15 minutes)

Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

Each team will explain to the class what information their team discovered about each substance. After all teams have shared their data, observations, and information, the class will try to agree upon and correctly deduce which bowl contains which ingredient. The teacher will ask the following during lesson questions: What did your team discover about each substance? Which bowl contains which ingredient? What different tests did you complete? What observations did you make? How did innovation play a role as you determined each ingredient? What was the most challenging part of conducting your research? How were you using the habits and skills of a scientist during this activity? How do scientists use

innovation? Why do scientists always look for examples of change? What other connections can you make to change from this experience? What connections can you make to innovation? What new ideas do you have about change and innovation? How are change and innovation connected? How does innovation drive change? (30 minutes)

Elaborate - Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways.

Next, students will take the information they have learned about ingredients and the new ideas they have about molecular gastronomy and the science of cooking to develop team cookie recipes. Each team will develop two different cookie recipes that are identical except for one test variable that they will change. For example, a team may make one recipe using only white sugar and one recipe using only brown sugar, or one recipe using baking soda and one recipe using baking powder. They will need to justify why changing this one variable represents an interesting scientific change and question to explore. Teams will need to have both of their recipes approved by the teacher. The teacher will guide students with the following post lesson questions: What two recipes will your team use? Which variable will you change between your two recipes? Why did you choose that variable to alter? What predictions can you make about how your two cookie recipes will be different? How will changing that one variable in your team's recipe will change your cookies? If you could change two variables, what other element would you like to test? What variable would you change if you were making pancakes instead of cookies? What variable would you change if you were making cake instead of cookies? How is testing these two recipes an example of change? How is testing these two recipes and example of innovation? What other types of innovative techniques could chefs use to make cookies? (20 minutes)

Once the team's cookie recipes are approved, they will actually mix and make the two unique batches of their two cookie dough recipes. Students will assemble the dough according to their two recipes, and then the cookies will be baked that night by the teacher, according to the team's directions. Students should follow their written recipes precisely when creating their cookie batter. (40 minutes)

Evaluate - This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.

At the end of the class period, students will each complete a half sheet exit slip answering the following questions: (5 minutes)

What are three connections to or examples of change that you found interesting today?

What are two new things you discovered about innovation?

How are change and innovation related?

Name: _____ Date: _____

LAB ACTIVITY: Mystery Materials

Brainstorm & Research: What tests can you perform to determine which substance is which?

	Substance A	Substance B	Substance C	Substance D	Substance E	Substance F
See						
Smell						
Feel						
Other						

Name: _____ Date: _____

LAB ACTIVITY: Recipe Planning

Team Name: _____ **Team Number:** _____

Original Cookie Recipe

Ingredients:

1 & 1/8 cup all-purpose flour
1/2 teaspoon baking soda
1/2 teaspoon salt
1/2 cup (1 stick) butter, softened
3/8 cup granulated white sugar
3/8 cup packed light brown sugar
1/2 teaspoon vanilla extract
1 large egg
1 cup chocolate chips

Instructions:

1. Preheat oven to 375° F.
2. Combine flour, baking soda and salt in small bowl.
3. Beat butter, granulated sugar, brown sugar and vanilla in large mixer bowl until creamy.
4. Add eggs, one at a time, beating well after each addition.
5. Gradually beat in flour mixture.
6. Stir in chocolate chips.
7. Drop by rounded tablespoon onto ungreased baking sheets.
8. Bake for 9 to 11 minutes or until golden brown.
9. Cool on baking sheets for 2 minutes; remove to wire racks to cool completely.

Team Brainstorming:

Team Name: _____ **Team Number:** _____

Recipe __A

Recipe __B

TEACHER NAME		Lesson #
Morgan Carney		4
MODEL	CONTENT AREA	GRADE LEVEL
Problem Based Learning	Science	Middle School (6-8)
CONCEPTUAL LENS		LESSON TOPIC
Change		The Perfect Cookie
LEARNING OBJECTIVES (from State/Local Curriculum)		
Writing 9-10.5 Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. Science 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. Science Chm.2.2.2 Analyze the evidence of chemical change. Science 8.L.2 Understand how technology is used to affect living organisms. Reading 7.3 Analyze the interactions between individuals, events, and ideas. Speaking & Listening 9-10.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to "uncover" the Essential Understanding)
Innovation drives change		How does innovation drive change?
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)
Students will know that - The steps in problem-based learning are 1) explore the issues, 2) list what you know about the problem, 3) develop and write out the problem statement in your own words, 4) list all possible solutions to the problem, 5) list actions to be taken with a timeline, 6) list what you need to know in order to solve a problem, 7) write up your solution with supporting documentation, 8) present and defend your conclusions, 9) review and reflect on your performance - Physical changes are often easier to identify than chemical changes - Innovative descriptions can change perceptions - Scientists can play many different roles - Scientists work as a team - Scientists collect, analyze, and present data - Scientists solve problems and create change through innovative ideas and innovative thinking - Collaboration is vital to innovation - Innovation drives change		Students will be able to - Collaborate with a team - Assign team roles - Plan and budget time - Make connections - Create and utilize a rubric - Evaluate using criteria - Defend a position - Synthesize and present information

GUIDING QUESTIONS

What questions will be asked to support instruction?

Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding

Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:
• What is your favorite food in the whole world? • What innovative language could you use to describe that food? • What are some examples of innovative language? (metaphors, similes, alliteration, nonsense words, onomatopoeias, etc.) • How would you describe that food? • What descriptive words or phrases could you use to describe that food? • When you visualize that food, what words or phrases come to mind? • When you think about eating that food, what words or phrases come to mind? • What changes could you make to make that food even better? • What innovative ideas could make the food better? • How does innovation drive change?	• Which cookie recipe should the managers of Bull City Sweets use to create the best cookies for their new bakery? • What key words and phrases do you notice? • What is important to remember when thinking about this problem? • Who is the audience for this problem? • Who else is involved or impacted by this problem? • What is the end goal of this problem? • What different elements and dimensions should be considered when thinking about this problem? • What do you already know about this problem? • What do you still need to know? • What steps do you need to take to answer these questions? • What are the strengths of each team member? • What different roles do you need to fulfill as a team in order to find solutions to this problem? • How can you work together as a team to solve this problem? • What questions do you have about this problem? • How could you put this problem into your own words? • Are there any changes that need to be made to our problem question? • What did you change between the two recipes? • Why did you change that part of the recipe? • What inspired you to make that particular change? • How did you use innovative ideas in the creation of your two recipes? • What steps do you need to take? • How will you make sure everything gets done in time? • How will you collect and organize your data? • What is your action plan? • What makes a perfect cookie? • What are the qualities of a good cookie? • What elements of the cookies and recipe will the managers be looking for in the best possible cookie? • What elements of the recipe did each team change? • Which version of the team’s recipe resulted in better cookies, and why do you think that recipe resulted in better cookies?	• What elements of change did you notice in this problem? • What elements of innovation did you notice in this problem? • What other questions do you now have about innovation and change? • What have you learned about innovation and change? • How are change and innovation related?” From individual student reflection page: • Which cookie recipe did your team choose as the best recipe and why? • What did you enjoy during this problem? • What was challenging during this problem? • What were your team’s strengths? • What were your team’s challenges? • If you completed this project again, what would you change or do differently? • In what ways were you embodying the skills, knowledge, traits, and habits of a scientist? • What elements of change did you notice in this problem? • What elements of innovation did you notice in this problem? • How are change and innovation related?

DIFFERENTIATION			
Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.			
Content	Process	Product	Learning Environment
Students will study food science and learn about elements of chemistry that are not included in the typical public middle school curriculum	Students will collaborate in teams to analyze each cookie/recipe using their self-developed rubrics. They will be asked to designate unique team member roles, create a team action plan, and budget their time as a team.	Students will work in teams to develop their own unique rubrics that they will use to analyze each recipe/product, and will create a professional presentation for the managers of the cookie company.	

PLANNED LEARNING EXPERIENCES
Engage and Connect - <i>This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.</i> As students walk into the room, they will each be given a half sheet of paper. The teacher will ask students to think about their absolute favorite food in the whole world and to visualize it in as much detail as possible. The teacher will ask the students the following pre lesson questions: What is your favorite food in the whole world? What innovative language could you use to describe that food? What are some examples of innovative language? (metaphors, similes, alliteration, nonsense words, onomatopoeias, etc.) How would you describe that food? What descriptive words or phrases could you use to describe that food? When you visualize that food, what words or phrases come to mind? When you think about eating that food, what words or phrases come to mind? What changes could you make to make that food even better? What innovative ideas could make the food better? How does innovation drive change? The students will have three minutes to write down as many innovative descriptions of their food as possible. After they have done this, they will be put in pairs. One student will read their descriptions to their partner and the partner will try to guess what food they are describing. Then they will switch and the other partner will get a turn to share. After the partner activity, the teacher will ask students to share out the most innovative descriptions that they wrote or heard during the activity, and the class will make a list on the board. (10 minutes) ***** Explore - <i>In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.</i> <u>1. Explore the issues</u> The teacher will introduce the following ill-structured problem to the students: "Our goal today is to figure out which cookie recipe we should present for the new bakery, Bull City Sweets, to use. Which cookie recipe should the managers of Bull City Sweets use to create the best cookies for their new bakery?" The teacher will write this problem on the board and the students will discuss this problem and identify the important elements. The teacher will prompt conversation with the following during lesson questions: "What key words and phrases do you notice? What is important to remember when thinking about this problem? Who is the audience for this problem? Who else is involved or impacted by this problem? What is the end goal of this problem? What different elements and dimensions should be considered when thinking about this problem?" (10 minutes) <u>2. List what you know about the problem</u> The class will discuss the following during lesson questions. As they discuss, the teacher will record ideas on the board. "What do you already know about this problem? What do you still need to know? What steps do you need to take to answer these questions?" (5 minutes) Next, teams will decide on the role of each person on their team. "What are the strengths of each team member? What different roles do you need to fulfill as a team in order to find solutions to this problem? How can you work together as a team to solve this problem?" The class will make a list of roles of a scientist and roles that might exist specifically on a Lead Food Scientist Team. Each team will develop and choose specific roles for each member of their team. These roles may include time keeper, note taker, data collector and graph maker, etc. (10 minutes) <u>3. Develop and write out the problem statement in your own words</u> The class will revisit the problem statement (Which cookie recipe should the managers of Bull City Sweets use to create the best cookies for their new bakery?) and put it into their own words and see if there are any changes that need to be made. "What questions do you have about this problem? How could you put this problem into your own words? Are there any changes that need to be made to our problem question?" Each student will write the problem on the top of their Data Collection page. (5 minutes) <u>4: List all possible solutions to the problem</u> Before students begin data collection, each team will present their two recipes and two sets of cookies to the class. They will state their team name and explain what they changed between the two recipes. (What did you change between the two recipes? Why did you change that part of the recipe? What inspired you to make that particular change?) We will make a list of all of the team names and recipe numbers on the board for teams to refer to later during data collection. (5 minutes) <u>5. List actions to be taken with a timeline</u> Students will be told that they have 30 minutes to conduct research with their team on all the cookies and recipes. Teams will be asked to make an action plan for how they will spend their time to collect data and organize their information. (10 minutes) ***** Explain - <i>Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.</i> <u>6. List what you need to know in order to solve the problem</u>

The teacher will lead a class discussion around the question, “What makes a perfect cookie?” As students share ideas, the teacher will record their thoughts on the board. Then each team will develop a list of four to five specific criteria that they will use to judge the other teams’ cookies and recipes. (What are the qualities of a good cookie? What elements of the cookies and recipe will the managers be looking for in the best possible cookie? What elements of the recipe did each team change? Which version of the team’s recipe resulted in better cookies, and why do you think that recipe resulted in better cookies?) Based on these criteria, they will develop a rubric to score each cookie/recipe, including specific measurements and examples of each criteria at three levels: Poor, Average, and Excellent. (15 minutes)

SNACK BREAK (15 minutes)

Next, teams will conduct their research, using the rubric that their team developed to evaluate each cookie and recipe. They will collect data and rate each cookie using their rubric scales, while also taking observational notes. As a team they will decide which recipe they will recommend to the managers of the company and why. They will use the scientific knowledge they have gained about ingredient properties, chemical reactions, and other scientific elements to explain why they think the recipe they chose created the best cookies. (30 minutes)

7. Write up your solution with supporting documentation

Teams will have 15 minutes to develop a presentation to give the managers of the cookie company. At the end of this time, each team will present their recommendation for the best possible cookie recipe, using evidence to support their decision. The teams may choose to use presentation tools such as posters or notecards when they give their presentation. (15 minutes)

8. Present and defend your conclusions

Each group will have five minutes to present the findings of their research and their final recipe recommendation to the company managers. After all teams have presented, the class will vote on the best cookie recipe to recommend to the company managers. (30 minutes)

Elaborate - Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways.

After the presentations, the whole class will come together to have a conversation about the following questions to connect today’s lesson with the essential understanding and concepts throughout the week. The teacher will guide the discussion using the post lesson questions: “What elements of change did you notice in this problem? What elements of innovation did you notice in this problem?” The teacher will then ask, “What other questions do you now have about innovation and change? What have you learned about innovation and change? How are change and innovation related?” and allow students to ask and answer questions among themselves. (15 minutes)

Evaluate - This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.

9. Review and reflect on your performance

Students will complete the individual reflection page to consider their experience and performance during this problem-based learning scenario. This reflection will also serve as an assessment of student learning during the lesson and throughout the week, related to the essential understanding. (15 minutes)

Name: _____ Date: _____ Period: _____
Problem-Based Learning: Planning

Team Name:

What is the problem that we are investigating? _____

Team Member Roles (What will be the role of each person on your team?)

Action Plan (What will each person do and when?)

Name: _____ Date: _____ Period: _____
Problem-Based Learning: Team Rubric Creation

Team Name: _____

What is the problem that we are investigating? _____

	Poor (0 points)	Average (1 point)	Excellent (2 points)
Criteria #1:			
Criteria #2:			
Criteria #3:			
Criteria #4:			
Criteria #5:			

Name: _____ Date: _____ Period: _____
Problem-Based Learning: Data Collection

Team Name: _____

What is the problem that we are investigating? _____

	Criteria 1:	Criteria 2:	Criteria 3:	Criteria 4:	Criteria 5:	Total Score	Notes and Observations
Recipe 1A							
Recipe 1B							
Recipe 2A							
Recipe 2B							
Recipe 3A							
Recipe 3B							
Recipe 4A							
Recipe 4B							
Recipe 5A							
Recipe 5B							
Recipe 6A							
Recipe 6B							

Additional Notes:

Name: _____ Date: _____ Period: _____

Problem-Based Learning: Reflection

Team Name: _____

Which cookie recipe did your team choose as the best recipe and why?

What did you enjoy during this problem?

What was challenging during this problem?

What were your team's strengths?

What were your team's challenges?

If you completed this project again, what would you change or do differently?

In what ways were you embodying the skills, knowledge, traits, and habits of a scientist?

What elements of change did you notice in this problem?

What elements of innovation did you notice in this problem?

How are change and innovation related?

V. Unit Resources

John Mayer. (2006). *Changing*. Los Angeles: Steve Jordan. (2006)

This song is utilized as a hook in the first lesson of the unit. It is intended to spark students to think about change from a wide variety of angles and perspectives.

Yarrow, K. (2012, April 1). How Technology Is Changing What We Eat. Retrieved May 26, 2019, from <https://www.psychologytoday.com/us/blog/the-why-behind-the-buy/201204/how-technology-is-changing-what-we-eat>

This article is utilized for the Taba lesson in this unit. It presents ideas about how technology is causing drastic changes in the world of food and food science. Students will be asked to identify any connections to the concept of change that they notice while reading this article.

Candy Chromatography Science Project: Candy Experiment. (2019, January 09). Retrieved May 3, 2019, from <https://learning-center.homesciencetools.com/article/candy-chromatography-science-project/>

This page provides an overview of the candy chromatography experiment that is performed during the first lesson of this unit. Materials, steps, and an explanation are provided.

Poole, C. F. (2000). Chromatography. Retrieved May 26, 2019, from <https://www.sciencedirect.com/topics/chemistry/chromatography>

This website gives an overview of the concept of chromatography. This is an excellent resource for teachers to use in order to gain a more thorough understanding of chromatography before completing the candy chromatography lab with students.

Institute of Food Technologists - IFT. (2010, July 19). A Day in the Life of a Food Scientist: MICHELE PERCHONOK. Retrieved April 6, 2019, from <https://www.youtube.com/watch?v=4wAC-ST77Ow>

This video is utilized during the Bruner lesson in this unit. It provides an overview of the work completed by food scientists who work for NASA and develop food to send to space. This video provides an interesting lens and glimpse into a type of science that students may not be as familiar with before this course.

Taylor, G., Meyers, J., & Donga, C. (2012, August 27). How to Make Your Own Dippin' Dots Ice Cream with Liquid Nitrogen. Retrieved April 6, 2019, from <https://food-hacks.wonderhowto.com/how-to/make-your-own-dippin-dots-ice-cream-with-liquid-nitrogen-0138904/>

This website provides an overview of how to create homemade “Dippin’ Dots” ice cream using liquid nitrogen. For teachers who are not familiar with this lab procedure, this is a vital resource to explore before performing this lab.

Liquid Nitrogen Ice Cream: Experiments: Steve Spangler Science. (n.d.). Retrieved May 13, 2019, from <https://www.stevespanglerscience.com/lab/experiments/liquid-nitrogen-ice-cream/>

This page provides an overview about liquid nitrogen and how to make another type of ice cream. Often students are very intrigued and excited by the idea of getting to use liquid nitrogen. It is a novel experience as it is hard to obtain and can be dangerous if not used with caution. This resource will help prepare teachers to understand more about liquid nitrogen and be able to share these ideas with students.

Carney, M. (2019, April 6). Bruner Lesson Hook. Retrieved April 6, 2019, from https://docs.google.com/presentation/d/1qRW9ebhtR1UMj42nu_jpu70Oh3FxknCBbl4Skpisk7g/edit

This resource provides a digital slideshow of pictures that can be used as a lesson hook. All of the pictures related to change in some manner. Students can be shown the photos and asked what they notice, leading to a conversation about the wide variety of changes that students can identify.

Azzam, A. (2016, April). Six Strategies for Challenging Gifted Learners. Retrieved April 23, 2019, from <http://www.ascd.org/publications/newsletters/education-update/apr16/vol58/num04/Six-Strategies-for-Challenging-Gifted-Learners.aspx>

This resource includes strategies and ideas that can be used to develop curriculum and lessons for gifted students. Ideas from this article were used to create this curriculum. Teachers using these lessons may find this resource helpful.

SPARK Summer Camp for Gifted Students. Retrieved November 2, 2018, from <http://central.dpsnc.net/advanced-academics/spark-summer-camp-for-gifted-students>

This page gives an overview of the SPARK Summer Camp program. Teachers who are unfamiliar with this program may want to browse this page to better understand the context for these lessons and this unit.