Are You Sense-itive?

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Grades 6th – 8th

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Introduction

This unit is based around the concept of interdependence and the essential understanding that interdependence influences perception. It is important for students to approach the material through a conceptual lens because it helps to broaden their understanding of the material in contexts beyond this unit. Most of the time the students are given information in their classrooms in a straightforward manner equivalent to regurgitation. Concepts provide overarching ideas that can cross between disciplines and units of study. Interdependence was an important concept to provide the students because it demonstrated how perceptions in their daily lives, even outside of the classroom, are interdependent.

Merriam-Webster does not include a definition for "interdependence." Rather, they refer one to the definitions for both "inter-" and "dependent" separately. Inter- is a prefix defined as occurring or shared between two or more things, while dependent is defined as "the state of being influenced or determined by another." Putting these two definitions together, one would conclude that interdependence is the shared state of two or more being mutually influenced by each other.

The simplest example of interdependence is an Aesop fable called *The Quarrel between the Body Parts*. The body parts felt the stomach did nothing while they all contributed to feeding it. The body parts revolted and refused to feed the stomach, which began to starve. However, the rest of the body began to starve as well and the whole body died before it could fix the problem. This fable demonstrates that links exists between things wherein each part relies on the others and is, in turn, affected by any change that occurs to the other parts. This is essentially interdependence.

The importance of interdependence was recognized by Mahatma Gandhi when he stated, "interdependence is and ought to be as much the ideal of man as self-sufficiency. Man is a social being." In this quote, Gandhi was referring to the interactions and dependence of one group of humans on

another. It is true that people rely on and are able to thrive because of a reliance on other people. The farmer needs the miller to grind his wheat, the miller needs the carpenter to build his mill, the carpenter needs the food the farmer produces; each person relies on, or is interdependent with, each other.

No organism can survive alone on this planet; all survive because of reliance on one another. Another example is looking at a food web. The bugs eat the plant, the birds eat the bugs, the fox eats the bird, the fox dies and the worms eat the fox, the plant is fertilized by the worms, the next bugs eat the plant; if any segment breaks or changes, the rest of the chain is affected as well. Martin Luther King, Jr. understood the unavoidability of interdependence when he said, "Whatever affects one directly, affects all indirectly."

Interdependence is the concept that ties everything together. The lens in which one can view interdependence of a system can vary by perspective. One might see an economic interdependence, while another sees an interdependence related to the ecosystem, and a third observes the interdependence that exists between parts in a bodily system. We cannot escape interdependence and it would be foolish to try. As psychologist Erik Erikson stated, "Life doesn't make sense without interdependence. We need each other, and the sooner we learn that, the better for us all."

The content around which I framed the student's look at interdependence was based on their senses and their perception. Many of them knew what the five senses were, but they had never questioned how they worked or how to know their senses were working accurately. One of the goals was to open their eyes to the reality that not everything was as simple as it seemed on the surface. The students began to question their surroundings and look at interdependence not only in their own lives (which is what our content was focused on), but to also have them expand this questioning to other areas.

In the student's normal classes, they do not ever discuss how the senses work. In the NC Standards, they are supposed to learn about how the body works, but this focus is set on the idea of the

major systems: digestive, circulatory, reproduction, motor. These help the organisms survive and reproduce, yet neglect how they perceive their environment and know how to appropriately respond to stimuli. This is unfortunate as every single second of every single day each one of us are taking in huge amounts of data from our senses and never once questioning it.

In this unit the students are challenged to develop their skills of questioning and then testing. While some science classes allow students to question and test, many force them to follow a strict series of steps when doing a laboratory experiment. One of the skills the students in this unit work to develop is creating their own experiment and developing a rationale for why the experiment happens the way it does. This expands on their mental capacities in a way that is not challenged in their normal classrooms. This unit is designed to take what they typically accepted as true (everyday perceptions) and make them realize that their world is not so simple.

Another skill the students develop is working with partners of similar abilities. This is a differentiation along learning environment as well. Typically, gifted students are working with partners whom are not their intellect peers. This can lead to the gifted student doing all the work instead of working in a collaborative environment. Working in this environment is also developing their skills of collaboration as they have to be prepared to present their experiment together. They are not allowed to have one person do all the talking or work. Many students, gifted or otherwise, are not comfortable talking in front of other people. However, in this day and age being able to effectively communicate with other individuals is arguably more important to employers than just knowledge. We are a connected society and have to be able to work together.

The students present their experiment to the rest of the class and this becomes their product. This product is differentiated for gifted learners since the students have to come up with a unique perceptional interdependence example. In many standard classrooms, the students would just follow

the script of an experiment. This product is differentiated for the gifted students as they have to develop an experiment on their own. This product also has the benefit of drawing on their interests as they have to look deeper into the senses that interest them the most.

Throughout this unit students are given the ability to explore the information on their own more and just sitting passively. I believe that the students develop deeper understanding when they get to mull it in their minds more than hearing a lecture. Therefore, this unit is designed to give the students the driving seat and regulate their learning. For example, one of the days is a Socratic Seminar where the students entirely lead the discussion and decide where the conversation goes (with minor interventions from the lead teacher). The students are able to probe each other in a safe setting and challenge each other's ideas in a non-aggressive way. This process allows the students to think and make their own decisions on topics such as which sense is the most important.

In terms of content, and as stated before, this unit covers material that is not typically taught in the schools, yet is important and will influence their daily lives, to an extent. Since the content revolves around their senses, which are constantly taking in information, they will be able to see the world in a different way each time they step out of the door, which also adds a level of complexity. The students are not always given ideas or concepts that challenge their daily lives.

Research shows that the typical high school student has an attention span of roughly 14 minutes. However, these 6^{th} to 8^{th} graders are given the challenge of acceleration by having to develop their understanding in four blocks of three hours. This is a challenge for them to stay focused and engaged while going at a rate that can be too fast for a typical high school student. Additionally, since the standards do not usually include how the senses function, it is another example of depth being added to the unit. This depth and acceleration is beneficial as the students are learning a little bit about the nervous system and how neurons work years before they otherwise would. High school biology is

generally the first instance of a science class addressing that specific system and how it relates to the senses.

Finally, the product mentioned earlier where the students create their own experiment is important as the students must find a way to be creative. Each pair develops their own experiment using their creative problem solving skills. None of the groups are allowed to find an existing experiment and, therefore, are challenged to be creative and find ways that the senses haven't been challenged. They are allowed to show interdependence between any two of the five senses.

Goals and Outcomes

Content Goal:

To understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

Students will be able to…

A. Hypothesize how the different senses function.
B. Explain how each of the five senses work on a biological basis.
C. Infer how the brain perceives stimuli based on interdependence.
D. Analyze how the brain reacts to conflicting stimulus.
E. Evaluate the effects of synesthesia on survival.

(From NC Essential Standards 7.L.1)

Process Goal:

To compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Students will be able to…

A. Evaluate class results of the experiments and create educated conclusions.
B. Analyze the reliability of perception through various readings and experiments.
C. Engage in a discussion in which they construct questions and sustain a dialogue about the reliability of each sense.
D. Discuss which senses are "stronger."
E. Compare and contrast conflicting results to develop an supported claim.

(From CCSS: ELA-LIT, RST 6-8.9)

Concept Goal:

To understand the interdependence [within living organisms].

Students will be able to…

A. Construct their own definition of interdependence.
B. Analyze the relationship between interdependence and perception.
C. Critique the different approaches to how one perceives the world.
D. Conduct an experiment in which one sense is deceived due to interdependence.
E. Explain how interdependence influences perception.

(From NC Essential Standards Bio 2.1)

Assessment Plan

Throughout the unit there are many times that the students will be evaluated using formative assessments, and then a final summative assessment. Formative assessments are necessary to ensure that the students are understanding the material and progressing accordingly. An effective teacher reflects not only post-lesson, but during the lesson as well in order to make sure that the students are not getting left behind. However, in the case of gifted students, the teacher might need these formative assessments in order to progress faster if they are finishing earlier than accepted while still developing understanding.

One of the ways the students were assessed informally was through the in-class discussions. We frequently had students talk in pairs with partners or discuss questions as a full group (see Lesson plans below for examples). After they discussed with a partner, I would cold call on students to hear their ideas. Cold calling also insured that all students would remain on task as they could not just sit back and pretend to engage with the content. Additionally, the students were then able to hear more ideas than just the ideas of the students who are more vocal or quick to put up their hand.

Another formative assessment was achieved by checking their folders at the end of every day. Each of the students had their own folder in which they kept all of their notes and handouts, and the folder stays in the classroom until the end of the unit. At the end of the lessons, the students would be given specific questions to answer in a written format on one of their notebook pages. After the class ended, I would flip through each folder and read their thoughts. Sometimes I would look for comprehension and understanding of material, and other times I would be looking for their personal thoughts and reflections. This feedback would help guide where I needed to go for the next day and how I could adjust to best meet their needs.

A final formative assessment was to go around and talk with the students as they worked on various experiments. I would eavesdrop or simply ask them questions about what they were discussing

with their partners. This helped me gather more informal knowledge of where the students were so that I could adjust on that specific day. There was one day they did not understand how one of the senses worked so I immediately altered the plans and postponed the next section in order to help develop their understanding before moving on to the next section.

In terms of the summative assessment, there was one large concluding task in which the students were paired up and had to create an experiment that demonstrated how interdependence influenced perception. This concept was the overarching essential understanding of the unit and showed in a more formal way that the students understood interdependence as a concept. Additionally, this project necessitated that the students demonstrate their understanding of the content in regards to how the senses worked since they had to verbally explain the process they were exploiting in the experiment. A copy of the performance task is below:

> *You aspire to be the world's greatest illusionist. Unfortunately, no one is willing to book your act yet. Luckily you and your team are about to get the break you've been waiting for. One of your friend's younger siblings is having a birthday party and they have offered to have you all perform some illusions. You have already shown off the tricks you learned during your first days at illusionist school. Now it is time for the grand finale. As a dynamic duo or as a sensational soloist, design a unique illusion that will trick at least one of the senses by using another sense. Both members of the duo will have to be able to perform the trick if necessary. After you finish your performance, be sure to explain to the younger kids how the interdependence influences their perception, but use words that they understand. Besides being ready to present your trick, you and your partner will have to produce a written copy of your trick (for other illusionists after you are gone) that explains how to do the trick and the rationale behind which perceptions are tricked.*

This performance task was an effective summative assessment as it challenged the students to tie in the concept of the unit with their understanding of the content. To accomplish this, the students had to fulfill the skills this unit outlined, such as working collaboratively and evaluating various sources of information.

Unfortunately, the students took their folders back with them on the final day of the unit so that they could share their knowledge and activities with their friends and families. This means that I do not

have solid proof of their accomplishments with this activity, as had been my goal. However, I will include several of the experiments that they conducted.

1) One group demonstrated that if they stroked a fake hand and a real hand while your real hand was out of view, the person would start to "view" the real hand as their own. Then when a hammer suddenly hit the fake hand, the person would respond as if they had felt it in their actual hand. This shows an interdependence between the senses of touch and sight, which they were able to explain at their level.

2) Another group had students try cups of different colored juices and rank which ones they thought tasted better. Unknown to the drinkers, all of the cups had the same juice but different food coloring. The students designing the experiment showed that students would often choose the color they liked the best as the best tasting one, despite the fact they should all taste the same.

3) The final example I will include had students tasting a food while having a different food under their nose. This showed the interdependence of smell and taste as the food they tasted did not taste like it usually did due to conflicting smells.

Each of these examples demonstrates how students had to combine their understanding of the content with the concept from which this unit is based and create an experiment that challenged and aided in the development of their process skills.

TEACHER NAME		Lesson #
Shaun Thompson		1
MODEL	**CONTENT AREA**	**GRADE LEVEL**
Questioning	Science	6th-8th

CONCEPTUAL LENS	LESSON TOPIC
Interdependence	Smell, Taste

LEARNING OBJECTIVES *(from State/Local Curriculum)*

7.L.1 Standard:

- Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

http://www.dpi.state.nc.us/docs/curriculum/science/scos/support-tools/new-standards/science/6-8.pdf

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)*
Interdependence influences perception	How does interdependence influence perception?

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… Their taste receptors are on their tongues, which causes the sensation of taste. The taste receptors are microvilli. The sense of smell is caused by neurons in their nose. The smelling neurons are in the olfactory bulb. Humans can detect 10,000 odors. The lack of smelling (due to hormones or sickness) can alter one's taste. Senses act together to provide information to our brains. Taste is one of humans' weakest senses. Animals smell along gradients. Interdependence is the mutual reliance of two or more groups upon each other.	Students will be able to evaluate which senses are "stronger." Students will be able to conduct an experiment to determine if smell influences taste. Students will be able to evaluate class results. Students will be able to develop the outline for an experiment to test interdependence and perception. Students will be able to analyze the relationship between interdependence and perception.

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 meal? How would you describe your favorite food? What is gustation? What is olfaction? What is smell? What is taste? How do we smell? How do we taste? What influences what we smell? What influences what we taste? Why are the streamers set up in the room? What do the streamers have to do with olfaction or gustation? What is perception? How do you think smell and taste are related? What is interdependence?	How might smell impact the way you choose your favorite foods? Why do you think you cannot taste food as well when you have a cold? How does olfaction work? How does gustation work? What is the relationship between smell and taste? Why are multiple senses important? How would you justify that senses are related? What is interdependence?	What other senses could be "duped" by the elimination of another sense? Where else do you see one system being overrun by another? What can you predict about the evolutionary development of our senses? How does smell and taste influence our eating habits? How did smell and/or taste guide our evolution? What is interdependence? What is interdependent between smell and taste? Smell and sight? How do you know interdependence influences perception?

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
I have different, sophisticated articles that go deeper into how the senses work (the nerves) for students who already have a solid background in the basis of neuroscience/chemical reactions as this content is above standard grade level material.	Students engage in in-depth critical thinking as they must evaluate and re-evaluate their stance as they receive more information and have to accommodate/assimilate their new understandings.	Students will be proposing their own ideas for experimentation. The more gifted students will be prompted to devise an actual experiment based on sight and taste, as we will be conducting that experiment the following class.	

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

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.*

We start the lesson looking at what students know about smells and taste. They will describe their favorite dishes to their partner using any descriptors they can think of. I will have a picture of my favorite meal, and maybe even have a sample of it (to have the smell permeate and reinforce the later concepts). We will then share their descriptions and note on the board how many of them relate to smell or taste. The students will also think of their least favorite dish and I will ask what they do if they have to eat it (most probably close their nose, but do they know why or have they made that cognitive connection yet).

I will then begin to pose the questions listed in the pre-lesson section about how they would define "smell" and "taste," as well as question how each of these senses work. Also: How is your choice of favorite food influenced by both of these senses? Which other senses play a role? What is perception? What is interdependence?

After they discuss in partners, I will post some of their answers on the board as possible hypotheses and also have a different column for a definition of perception and interdependence. I will then draw their attention to the

construction paper with pieces of streamers coming off it that are attached to the ceiling. I will have them turn to their partner again and have them question why I have this set up based on smell and taste.

I then will demonstrate how the sense of smell works by releasing a helium balloon that will rise up through the streamers (mimicking passing through the membrane) and then triggering the neuron (the construction paper). I will then ask the students, what could influence this system? What factors could alter this process?

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.*

The students then will read an article (https://www.tsbvi.edu/seehear/summer05/smell.htm) about how smelling works. They will read the article (which explains smelling in more detail and relates to blind people and their sense of smell). They will come up with five higher order questions regarding the above article; no questions that can be answered yes/no. I will model some of these types of questions. I will be walking around facilitating their question generation. I will also offer a prize (candy but with stipulations on how they have to eat it since this is a lesson on taste) for creative questions in order to try to elicit higher order thinking questions.

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.*

I will show a short PowerPoint with some additional key information in order to review the information they just learned, as well as clear up any confusion. Now that the students have more of a background in how smelling works, we will go back and look at the beginning activity about their favorite dish and their least favorite dish. They will answer the following questions and re-evaluate the hypotheses they made at the beginning. Which parts of the hypotheses fit with their new knowledge and which ones did not? They will begin to make a new hypothesis after sharing their own questions from the reading and trying to answer them as a class.

We also want to test how strong our sense of smell is. First, there will be about 10 black canister with certain things at the bottom, but with a cotton ball over the top to restrict one from seeing the contents. The contents can be sawdust, ginger, peppermint, chocolate, vanilla, banana, corn chips, garlic, coffee, etc. The students then try to identify the contents by smell alone. Then they will attempt to identify some canisters that have a mixture of these scents like lemon-ginger, mulch-cedar, vanilla-chocolate, garlic-peppermint. We will go over the number of contents they got correct. Which were hard to guess? Which were easy? Why do you think this?

Next, we will go outside and evaluate how strong the sense of smell really is. I will ask them how dogs typically smell and if any one thinks they can smell as well as a dog. The volunteers (maybe have a couple different set ups) will be blindfolded and given garden gloves to reduce their sense of touch. On the ground, staked in, will be a rope previously soaked in peppermint oil. The students will have to follow the rope (which winds different directions) using just their nose. Those observing the experimentees will be mapping on their paper the movement of the experimentee. When we return to the classroom, we will discuss what we noticed about the tracking of the sniffer. The pattern should reveal the sniffer moved back and forth along a gradient.

Explore/Explain 2 –

Students will then receive an article about tasting (http://udel.edu/~bcarey/ART307/project3/contents/taste.html) and repeat a similar set of instructions as when learning about smell. They will come up with questions and we will go over them and compare their new knowledge to their previous hypothesis of taste.

Before going on to the experiment, we will review and begin to apply what they have learned so far by going over a short PowerPoint. The students will answer the first 4 during lesson questions in order to begin to think more critically about the senses.

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*

I now pose the issue to the students that they have said from their own experiences that smell seems to trigger a taste reaction and that they learned since blind people are devoid of one sense (sight) they seem to have more sensitive olfaction, how might losing the sense of smell effect their sense of taste? I will push them to see the interdependence in play here. I will have created the outline of a graphic organizer and explain that scientists use similar techniques in their laboratories. Each group will get a G.O. and be responsible for accurately recording the results. With partners, they make hypotheses and begin the experiment I have prepared. One in each group of two will be blindfolded as well as given nose-plugs (or just tightly hold their nose closed). They then eat a small piece of food and have to guess if it is apple or potato (they should not be able to tell when they lose their sense of smell). The other records the answer for both trials and then they switch who eats and who is sensory deprived. The class will then return all their results for how many people could accurately guess and how many could not tell the difference.

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

The students will then re-evaluate their predictions about smell and taste. They share their insights with the whole class and have to share questions they have come up with in regards to a next potential step or related to what they have learned thus far. These questions will have to be higher level questions; i.e. predict, elaborate, critique, etc. with no questions that could be answered yes/no. After sharing questions, they also answer the last 3 during lesson questions as prompted by the teacher.

We will now begin a conversation about what is interdependence. I will propose the question, what do wolves have to do with rivers? Within small groups the students will devise an explanation for the connection of the two. Then we will watch this video https://www.youtube.com/watch?v=ysa5OBhXz-Q showing the interdependence of the wolves and rivers. I will then have the students return to their groups and define interdependence and find two other examples of where we see interdependence. The class will then share their examples and definitions.

Explore:

Since they are already questioning their ability to really taste or smell things, I will allow them to test their tasting by sampling some bitter fruits (lemons, limes, grapefruit, pineapple, green grapes, granny smith apples, pickles). Then they will allow a “miracle fruit” tablet to dissolve on their tongue. The students then taste the fruits again and rate them on their sweetness. After sharing results, I will ask the students, based on what they know, why they think the fruit tasted sweeter the second time. How was their perception altered? We will go over the fact that the miracle fruit bound to the receptors and the next foods created a release of sweet receptors.

Recalling the students to the earlier exploration and leading into day two on sight, I will ask the students how the elimination of sight influenced our ability to perceive the peppermint smell. How would this have been different if the students were not blindfolded (assuming they couldn’t see the string)?

Finally, in small groups, the students will finish the time they have left by answering the post lesson questions, or if they are unable to answer the questions, how could they develop an experiment to find the answer. This will remain in their folder since we will refer back to it later.

Scent Identification

Scent	Emotional Response	Identification
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		

Blindfolded Taste Identification

Hypothesis:

Rationale:

Food	Guess	Actual
A		
B		
C		

Tracking Diagram:

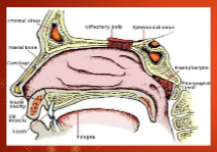
Miracle Fruit Tablet

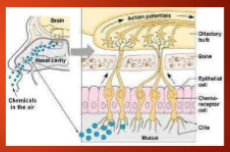
Fruit	Before Tablet Observation	After Tablet Observation

Welcome!

Smell

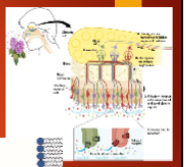
The Nose

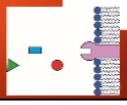




How the nose smells

- On the olfactory epithelium (patch of neurons inside the nose) there are cilia
- Molecules bind to the receptors on the cilia
- Molecules work like a hand in a glove
  - Molecules bind to receptors that match its shape, but there is some wiggle room
- When the neuron receives the receptors, it releases neurotransmitters which send an electric signal to the brain
- The brain interprets the signal as smell





What has smell?

- Objects that have volatile molecules
- Volatile – easy to evaporate
- When you breath in, you are taking in molecules that have evaporated from objects!
- Coffee is very volatile, so it has a strong smell
- Steel is not very volatile, so it does not have a strong smell
- Something that smells stronger has a higher concentration of molecules

What do we use smell for?

- It protects you!
  - Dangerous objects (rotten food, poison, etc.) often smell bad
- It takes in information about your surroundings
  - Recognizing a pleasing smell or displeasing smell will help assess surroundings
- Helps you taste!
  - When you eat, molecules from food float up to the nose and help you taste more fully

Did you know…

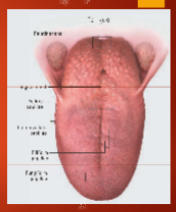
- You can recognized smells from 5 years ago
- Humans can detect 10,000 ordors
- Like a fingerprint, everyone has a unique smell
- On average, women are better smellers than men, and men lose their sense of smell earlier
- Smell can affect your mood (aromatherapy)
- Some of the most pleasing smells to humans are fresh bread, recently cut grass, and coffee

- How might smell impact the way you choose your favorite food?
- Why do you think you cannot taste food as well when you havea cold?
- How does olfaction work?
- How does gustation work?

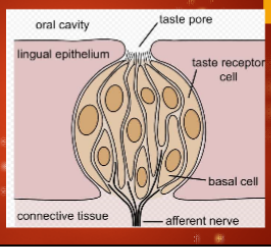
Taste

The Tongue

- There are little bumbs, called papillae all over the surface of the tongue
- Tiny taste buds are on the papillae in fungiform
- Contains many different muscles used to talk and push food around the mouth
- 5 tastes: sweet, bitter, salty, sour, savory (umami)



Taste Buds



How the taste bud tastes

- At the tip of the taste bud is a small hole called the taste pore
- Little hairs, microvilli, extend up through the holes and act as taste receptors
- When flavor molecules find their way to the receptors, the receptors send a message to the brain and the brains interprets this as taste
- The message also goes to the limbic system which controls emotions and memory
  - Why can we feel pleasure when we eat foods we like?

More on Taste…

- People can taste things differently because of the difference in how our taste receptors developed (genetics)
- Taste is heavily influenced by smell
- Taste keeps you safe!
  - Things that can harm you usually taste bad
  - Poisons are often bitter
  - Unripe or rotten food is sour

Did you know…

- Humans are born with 10,000 taste buds, but they die as you get older. Adults may have only 5,000
- Changes in hormones, sinus problems, and nasal congestion can alter taste
- Girls usually have more taste buds than boys
- Spicy food stimulates pain receptors, not taste buds
- You usually like/do not like the food your mother likes
- You can learn to distinguish tastes (wine, coffee, tea, cheese)

TEACHER NAME			Lesson #
Shaun Thompson			2
MODEL	**CONTENT AREA**	**GRADE LEVEL**	
Taba Concept Development	Science	6th-8th	

CONCEPTUAL LENS	LESSON TOPIC
Perception	Sight, Sound

LEARNING OBJECTIVES *(from State/Local Curriculum)*

7.L.1 Standard:

- Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

http://www.dpi.state.nc.us/docs/curriculum/science/scos/support-tools/new-standards/science/6-8.pdf

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)*
Interdependence influences perception	How does interdependence influence perception?

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… Sight occurs when light passes through the cornea and stimulates receptors in the pupil. There are two different kinds of receptors in the eyes, rods and cones. Rods are used more in dim conditions and are more associated with night vision. Cones are for brightly lit scenarios and are associated with sharp images and colors. We can only see certain wavelengths. Hearing occurs from sound bouncing off of the curves in the outer ear. Hearing is a mechanical sense, compared to a chemical one (taste, smell). Ears control balance through fluid in the cochlea. Perception is becoming aware of something through your senses.	**Students will be able to…** Explain how hearing works. Explain how sight works. Evaluate how perception is not always accurate. Analyze and critique the different approaches to how we perceive the world. Create a "hidden message" by applying their understanding of how vision works with colors.

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 interdependence? What is perception? How does smell work? How does taste work? Based on your knowledge of the other sense, how do you hypothesize sight works? What is the relationship between optical illusions and perception?	What is perception? Which factors influence perception? How is taste and sight interdependent? How is does perception influence sight? How does perception influence taste?	How can perceptions be deceived? Why does this happen? Which occupations are more effected by perception challenges? How can we do to avoid deceptions, or misperceptions? How does interdependence influence perception?

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 are given more formal reading with technical terms that their standard counter-parts would not receive in order to deepen their knowledge on the subject.	Students engage in in-depth critical thinking as they must evaluate and re-evaluate their stance, as there is no "right" way when critically thinking.		

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage - *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 will start by reviewing what we had done the day before by asking what is interdependence and having someone explain how smell and taste works. Then I will have them look at a mystery food (buffalo chicken dip, or passionfruit, or cottage cheese). I will have them describe how it looks to them and how appealing does it seem, as well as rate on a scale of 1-10 how much they think they will like it. Then they will taste it and be asked to rate how much they actually liked it. (*My idea is to try to remind them of yesterday and get them moving towards today's topic.)*

Connect –

Then I will have the students get into groups around the pre-set up cups of Kool Aid. There will be four cups at each station. Each of the cups actually has the same amount of sugar in them, but differing amounts of food coloring. Each student will taste the four cups and then record the strongest to least strong flavor. We will then make a class chart. Then they return to their stations for the next part. In this part there are 5 cups and each have the same amount of food coloring, but different amounts of sugar. Again they record the intensity of flavor. We will compile class results and then discuss them. Which experiment was easier to rate? How did the food coloring effect your rating? Why did the food coloring effect your rating? What assumptions did you have?

Now, hypothesize how sight works. Then I will show them an optical illusion like https://media.mnn.com/assets/images/2017/01/Rabbit-Duck-Head-Optical-Illusion.jpg.838x0_q80.jpg or http://brainden.com/images/old-couple.jpg . What do you see? What else do you see? What makes you say that?

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.*

I will begin a short PowerPoint that has the basics of vision on it and how sight works. I will have different color glasses and the students can look at the pigments and how color is affected when you combine them. The students will then be directed back to the optical illusions that dealt with colors and will be asked to re-evaluate their

hypotheses. The students are then given a sheet that can demonstrate where their blind spots are in their vision, as well other optical illusions to work with and question what is going on and why they think this is happening.

Next, the students will then read this article on perception https://www.simplypsychology.org/perception-theories.html (I probably will shorten it and take out a section or two). After reading this article, we will begin to compile a list. What words of phrases do you find in the article that relate to perception? List all the words and/or phrases you find that are related to perception or what influences perception. At times I will ask them to rephrase or clarify what they are saying into more succinct words and phrases. I will be writing all the answers on the board so they will be able to see the list.

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.*

Next, the students will begin to group the items together in their team of three. Which items go together? The rules are that no word can be used more than once, there needs to be at least four distinct groups with at least three words in each group. I will be moving around to give advice and help as they move on to labeling the groups after putting them together. Now the students will justify the reasons why they grouped specific words/phrases together.

Also, we now will watch https://www.youtube.com/watch?v=IGQmdoK_ZfY experiment about how our perception is limited when we only pay attention to certain details. This can relate back to the Kool Aid experiment earlier by me prompting them with questions. How is this like the Kool Aid experiment? Where was your focus for each of these? How does interdependence influence perception in each of these situations?

Explore #2 –

Pausing from the grouping, we will look into how hearing works. There is a short PowerPoint with a few slides explaining the structure of the ear and how vibrations cause us to hear things. I will have something that is like a drum head and show that by talking/producing sound towards it, you can see the surface ripple. That is similar to what happens in the ear canal.

Now students will watch a video https://www.youtube.com/watch?v=G-lN8vWm3m0 about the McGurk effect. What other sounds do they think will cause this? How does this effect perception? Which occupations might be most affected by the effect?

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*

Having seen more about perception, students will return to their groups and work to create new groups for their words. However, we will add a few more words to the wall if they have decided our list was not quite comprehensive. The rules are that the words/phrases can be used more than once, each group still needs at least three items, and all the labels connecting the items in a group must be new. The students will share their groups with the class at the end of this time.

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

After sharing with the class, the students will individually write generalizations about perception from what they have gathered from the grouping and discussion. These generalizations will be based on the idea of perception and how it is influenced by various inputs. Individually, I want them to think of how can we be sure we perceive

something accurately, and how could we trick another person's perception of an object.

Explore/Explain:

We will now have the students take their knowledge a little further. The ear is also responsible for balance as well as hearing, as briefly mentioned earlier during the explaining the structure of the ear. However, it is more complicated than that as the balance relies on input from the eyes and muscles as well as the inner ear.

I will have the students see how easily they can balance with their eyes open and fixed on a certain point. Then I will have them be blindfolded and try the same thing. Which was easier? Why do you think that? How else could balance be improved/worsened? How does perception influence our movement?

This last experiment will combine with their post-lesson questions of how else perception can be challenged. On the next two days, students will start designing an experiment/challenge to try and trick one sense by using conflicting information from a second sense.

Tasting #1

Rate 1-4 with one being Least Intense

Least Intense	**2nd Least Intense**	**2nd Most Intense**	**Most Intense**

Tasting #2

Least Intense	**2nd Least Intense**	**Middle Intensity**	**2nd Most Intense**	**Most Intense**

Blind Spot Activities

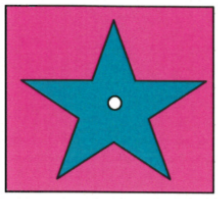
Close the right eye and look at the shape on the right. Move the paper closer to your face until you can no long see the circle on the left. Continue to move the paper closer and the circle will reappear. Repeat with the left eye closed, watching the circ le on the left.

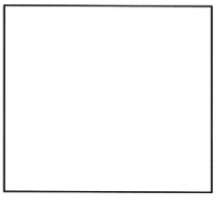
With the right eye closed, look at the red circle. Slowly move the paper closer to your eye. At a certain distance, the blue line will no longer have a gap in it. Your brain is filling in information that is not there.

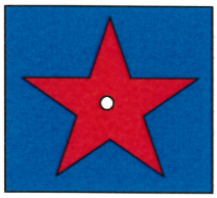
1 2 3 4 5 6 7 8 9

With your left eye closed, look at the number 1. Hold the paper about 8-10" from your eye. Slowly look at the next numbers 2, 3, 4, etc. At which number does the star on the right disappear? At what number does the star reappear? Try this at different distances from your face.

Afterimage Activities

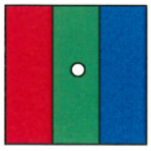


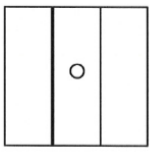




Stare at the dot in the middle of the yellow star for 15-30 sec. Move your gaze to the empty box in the middle. What did you see? Try it again with the other stars and boxes. What you see is called an 'afterimage." Look at the Light Color Triangle on the handout for the Intro to the Visible Light Spectrum. What is the relationship between the yellow star and the green box? What is the relationship between the star that you saw when you moved your gaze to the white box in the middle?

Does it work with three colors?





Welcome Back!

Day 2

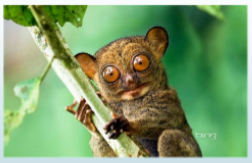
Tasting #1 - Class average

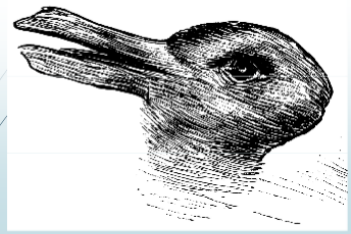
Least Intense	2nd Least Intense	2nd Most Intense	Most Intense

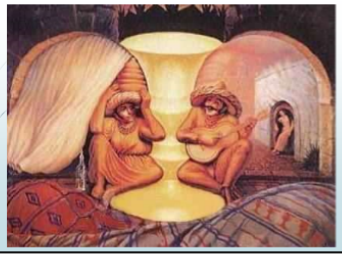
Tasting #2 – Class Average

Least Intense	2nd Least Intense	Middle Intensity	2nd Most Intense	Most Intense

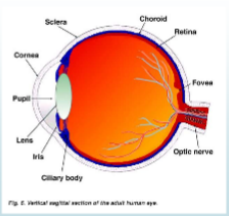
Sight





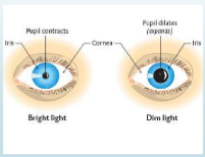


The Eye



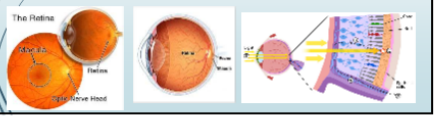
How The Eye Sees

- Light rays enter the eye through the cornea and go through the pupil (black center)
- The iris (colored part) controls how much light goes through the pupil by expanding (in dim light) or contracting (in bright light)



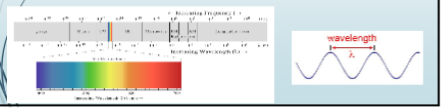
The Retina

- There are millions of nerve endings on the retina called rods and cones
- Cones – located at the center of the retina (called the macula), these work best in bright conditions and provide a sharp image with colors and detail
- Rods – located outside the macula, used for peripheral vision, detects motion, used in dim conditions (less detail and color)
- When light falls on the retina, the image is upside down, the brain inverts the image when it receives the signals.



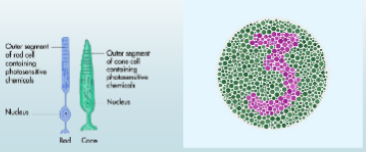
Light

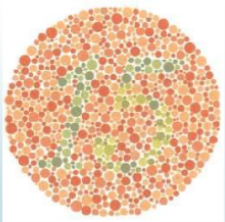
- Light can either be a wave or photon (packet of energy)
- For vision, we think of light as waves
- Different light has different wavelengths
- The Electromagnetic Spectrum shows all different kinds of light
- Humans can only see a specific range of light called visible light
  - Within visible light, different frequencies create different colors
  - We see color when an object's pigment absorbs certain wavelengths but not others, the colors not absorbed are the colors we see

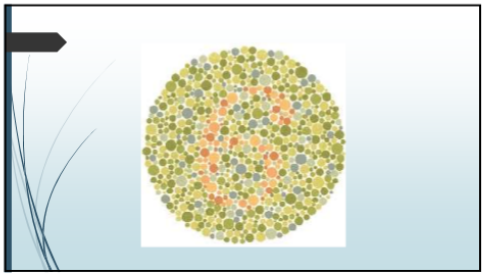


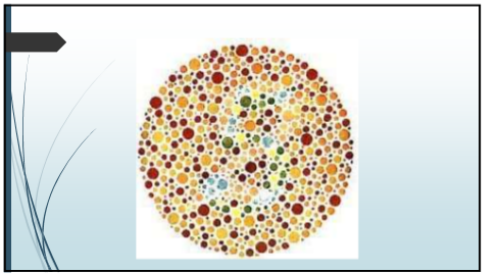
Color Blindness

- More common in males because it is sex-linked
- Cones do not develop properly
- Have trouble seeing the difference between certain colors
  - (red-green, blue-yellow)



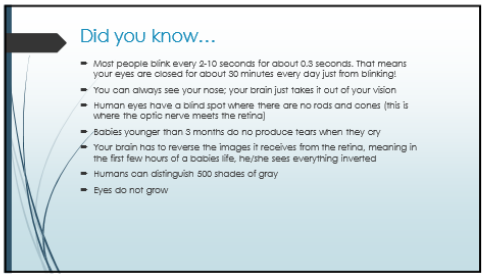


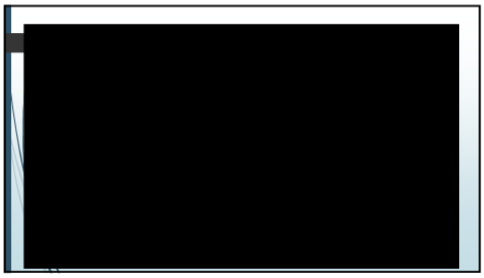


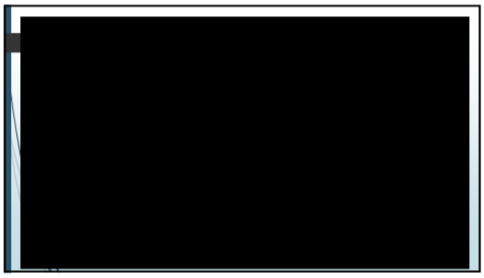


Did you know…

- Most people blink every 2-10 seconds for about 0.3 seconds. That means your eyes are closed for about 30 minutes every day just from blinking!
- You can always see your nose; your brain just takes it out of your vision
- Human eyes have a blind spot where there are no rods and cones (this is where the optic nerve meets the retina)
- Babies younger than 3 months do no produce tears when they cry
- Your brain has to reverse the images it receives from the retina, meaning in the first few hours of a babies life, he/she sees everything inverted
- Humans can distinguish 500 shades of gray
- Eyes do not grow







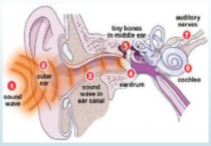
Hearing

The Ear

- Outer Ear
  - Opens into the ear canal
  - Eardrum serves as a barrier between the outer ear and the middle ear
- Middle Ear
  - Contains 3 small bones
    - The ossicles (hammer), the malleus (anvil), and the incus (stirrup)
- Inner Ear
  - Contains the cochlea, which has tiny hairs to pick up vibrations
  - Contains the auditory nerve

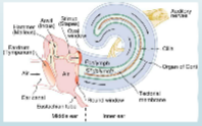
How it works

- Vibrations are sent through the ear canal and strike the ear drum, causing it to vibrate
- The sound waves travel to the anvil, hammer, and stirrup, which amplifies the sound
- The tiny hairs in the cochlea pick up the vibrations and convert to electrical impulses
- The impulses travel down the auditory nerve to the brain, where the brain interprets the signals



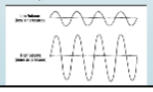
More on Hearing…

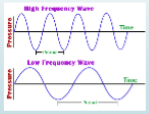
- Sound waves bounce off curves in outer ear in a pattern
- Brain can interpret the pattern of waves to determine the direction
- The brain can also determine position by comparing messages from left and right ear
- Hearing is much more mechanical than the other senses as it turns a physical movement into an electrical impulse



How Sound Works

- Sound waves are produced when something vibrates in the atmosphere
- The particles then move in a pattern (pulse) through the atmosphere
- We hear different sounds because of different frequencies (speed at which particle vibrates
  - High frequency – high pitch
  - Low frequency – low pitch
- The level of pressure is the waves amplitude
  - High pressure – loud
  - Low pressure – soft





Did you know…

- The hammer, anvil, and stirrup are the smallest bones in the body
- The ear is always working, even when you sleep
- Dogs can hear higher frequencies than humans
- A sonic boom occurs when an object breaks the speed of sound; the sound waves from behind and front of the object crash into each other
- A whip creates a noise because the tip is traveling faster than the speed of sound
- Ears self clean by producing wax, which is pushed out by the cilia

Balance

- The ear also controls balance
- The tubes in the cochlea contain fluid
- When we move our bodies, the fluid moves as well
- The moving fluid causes sensory cells to bend
- The cells then send electrical message to brain for interpretation, which the brain relays to other parts of the body
- We get dizzy when the fluid in our ear is moving but our body isn't

5

TEACHER NAME		Lesson #
Shaun Thompson		3
MODEL	**CONTENT AREA**	**GRADE LEVEL**
CPS	Science	6th-8th

CONCEPTUAL LENS	LESSON TOPIC
Perception	Touch

LEARNING OBJECTIVES *(from State/Local Curriculum)*

7.L.1 Standard:

- Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

http://www.dpi.state.nc.us/docs/curriculum/science/scos/support-tools/new-standards/science/6-8.pdf

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)*
Interdependence influences perception	How does interdependence influence perception?

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… The epidermis is the top layer of the skin and contains touch receptors. The dermis and subcutaneous tissue are the 2nd and 3rd layers of skin, respectively. There are four types of receptors in the skin: mechanoreceptors, thermoreceptors, pain receptors, and proprioceptors. Mechanoreceptors are feel pressure, vibration, and texture. Thermoreceptors register temperature. Pain receptors register cuts, burns, and poison. Proprioceptors sense the position of other parts of the body.	**Students will be able to…** Hypothesize how the perception of touch works. Identify which areas are the most sensitive. Analyze how the brain reacts to conflicting stimulus. Infer how the brain perceives stimuli based on interdependence. Construct their own perception "trick." Evaluate their "trick" for potential improvement opportunities.

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 a stimulus? How does one stimuli influence the perception? In what ways are perception and stimuli the same? How are they different? How does our sense of touch work? What does our skin do? What part of the body (skin) is most perceptive? How is touch interdependent on the other senses? sensitive	What is the advantage to different parts of the body being more or less sensitive? How would the sensitivity change if more senses were involved? In what situations does sight influence tactile perception? What is another "trick" to your perception?	Why did you decide on this "trick"? How does the trick reflect your planning? What modifications did you make? What changes would you make in the future? What might pose a problem for this trick? What did you learn about perception? What did you learn about interdependence? How does interdependence influence perception?

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
	CPS is an instructional model which is open-ended and requires advanced problem-solving.	Students are tasked to design their own original "trick" which involves conflicting stimuli when forming a perception.	

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

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.*

This image (https://www.pamperedchef.com/iceberg/com/product/1367-3-lg.jpg) will be on the board when students walk in. I will ask, what is going on in this picture? Why do you say that? Why is this happening? Then they will look at this picture (https://68.media.tumblr.com/34f0b32a20645bb130b667dcfa7968ac/tumblr_o6a709cLux1vo16dbo1_1280.jpg) and answer the same questions. This is to get them thinking about the sense of touch and the different receptors associated with touch.

The students begin with two activities that they will rotate between two stations. They will have been given a sheet with which to record their data on before beginning the activity. At one station they put one hand in a cold water bucket and one hand in a hot water bucket for 30 seconds, and then put both into a warm water bucket. They then will record their observations. They are encouraged to try different variations of moving hands around. The second station is having them move one finger along a rough surface (carpet) and a finger of the other hand along a really smooth surface (plastic or metal). Then move both fingers over a relatively smooth surface, like a wall. Have the students record their observations. We will come together as a class after everyone has had a chance to try both stations. After reflecting upon their gathered notes, the students will be asked to hypothesize what happened and how the sense of touch works. How does one perception/stimulus influence the next? How is touch interdependent?

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.*

The students will be engaged with a short PowerPoint that includes slides depicting how the sense of touch functions. They then will then be asked which part of the body is the most sensitive to touch. Why do you they think that? How could we test this?

Students in small groups will be given a ruler, paper clips, and an eraser. They will push the paperclip ends through the eraser and test their sense of touch by slowly moving the distance between the paperclip ends closer and closer. The one being touched is blindfolded and their partner is the one using the paperclip to gently touch their partner in the below specified areas. They touch a specific part of their body with the prongs and once they can no longer distinguish that there are two distinct prongs (it feels like just one), they record the distance using the ruler for that specific spot. The parts of the body include: lips, calf, elbow, fingertip, palm, forearm, forehead. Every now and then have the partner prick with just one end to check that the student is not simply guessing.

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.*

The class will then reconvene and everyone will add their numbers to a class list, which will then be averaged so we can discuss the results as a class. Where was most/least sensitive? Why do you think this was? What advantage might that have to be more/less sensitive? How do they believe their sensitivity would change if their eyes were open? What if they were listening to loud music vs. a quiet room? Some of these questions will be class questions and some will work with their partners to answer in order to allow time to reflect.

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*

Students will then gather together and proceed to the final demonstration. I will show how by stroking a hand that is out of view and simultaneously stroking a fake rubber hand, the person will start to associate the hand on the table with their own body (for reference: https://www.newscientist.com/article/dn16809-body-illusions-rubber-hand-illusion/). I will ask the students, in pairs, to try to explain why they think this is. When else does sight influence a tactile sensation?

Engage #2 –

Mess Finding: Student will now be placed into groups of 2. They will be given a prompt that they have been selected to perform a magic show for their younger sibling. However, the younger sibling has already seen the tricks to perception they have been exposed to this week. Now the students will have to develop a new perception trick that relies on conflicting senses using their knowledge they have gained about how the senses work.

Explore #2 –

Data and Problem Finding: The students will be able to look at the variety of stuff I have already procured as well as think of other resources at their disposal. They are also encouraged to write down and compile their information about how they have already seen the senses interact with each other.

Explain #2 –

Idea Finding: Students will be given time to work together in their groups and come up with possible situations which would trick senses. They are encouraged to think of a variety of ways without judgement since they might be able to use parts of those ideas later.

Solution Finding: Students will now begin to test and construct their "trick." They will be performing/demonstrating their trick to the other groups on the following day. All the while they will be reminded to think about how interdependence influences perception.

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

Acceptance Finding: Students are evaluated on their ability to work together and come up with a plausible idea. In the final minutes, the students will be asked to respond in writing to the following questions: Why did you decide on this "trick"? How does the trick reflect your planning? What modifications did you make? What changes would you make in the future? What might pose a problem for this trick? What did you learn about perception? What did you learn about interdependence? How does interdependence influence perception?

Hand Sensitivity

Please describe the sensation of each hand in the respective bowls/board.

Hand	First Bowl	Second Bowl
Left		
Right		

Hand	First Board	Second Board
Left		
Right		

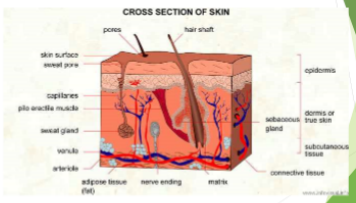
Pressure Sensitivity

Body Part	Distance (mm)
Fingertip	
Palm	
Forearm	
Forehead	
Lower lip	
Calf	
Cheek	

Body Part	Distance (mm)
Nose	
Foot	
Belly	
Shoulder	
Thigh	
Upper arm	

Touch

The Skin



The Skin

- Epidermis
  - Top layer made up of dead skin cells
  - Protective wrap for underlying skin layers and for rest of the body
  - Contains melanin, which protects the skin against harmful sun rays
  - Contains touch receptors
- Dermis
  - Contains hair follicles, sweat glands, blood vessels, nerve endings
  - Helps sustain the epidermis by pushing its dead cells up towards the surface
  - Eliminates waste through the swear glands and oil
- Subcutaneous tissue
  - Fat and connective tissue
  - Fat acts as an insulator
  - Acts as cushion to protect internal organs

Touch

- Touch is controlled by somatic sensory system
- 4 Receptors:
  - Mechanoreceptors - Pressure, vibration, texture
  - Thermoreceptors - temperature
  - Pain receptors - cuts, burns, poison, internal or external
  - Proprioceptors - sense the position of other body parts, like muscles, tendons, etc.
- Receptors are stimulated by a trigger, they send electrical signal to brain to be interpreted

Touch

- Different types of touch:
  - Intimate - calms you down
  - Healing - allows you to relax
  - Exploratory - feeling different textures, shapes, etc.
  - Aggressive/Painful - causes discomfort

- Your brain combines different stimuli
  - Temperature and texture of cold water falling on the skin

Did you know...

- You have more pain receptors than any other kind of receptors
- The most sensitive areas are the hands, lips, face, neck, tongue, fingertips, and feet
- Touch is the first sense to develop in humans
- Touch from a loved on can lower blood pressure and heart rate
- Goose bumps are little pimples that help retain a layer of warm air over the body
- The skin is the largest organ in the body, it weighs about 6-10 pounds

Typical Average

Body Part	Distance (mm)
Fingertip	2-3 mm
Palm	10 mm
Forearm	35 mm
Forehead	35 mm
Lower lip	4-5 mm
Calf	45 mm
Cheek	6 mm

Body Part	Distance (mm)
Nose	7 mm
Foot	20 mm
Belly	30 mm
Shoulder	41 mm
Thigh	42 mm
Upper arm	39 mm

- What advantage is there to a spot being more or less sensitive?
- How would their sensitivity change if they were listening it loud music? Soft music? Had their eyes open?

Urgent!

- You aspire to be the world's greatest illusionist. Unfortunately, no one is willing to book your act yet. Luckily you and your team are about to get the break you've been waiting for. One of your friend's younger siblings is having a birthday party and they have offered to have you all perform some illusions. You have already shown off the tricks you learned during your first days at illusionist school. Now it is time for the grand finale. As a dynamic duo or as a sensational soloist, design an illusion that will trick at least one of the senses by using another sense. Both members of the duo will have to be able to perform the trick if necessary. After you finish your performance, be sure to explain to the younger kids how the interdependence influences their perception, but use words that they understand. Besides being ready to present your trick, you and your partner will have to produce a written copy of your trick (for other illusionists after you are gone) that explains how to do the trick and the rationale behind which perceptions are tricked.

- Why did you decide on this "trick?"
- How does this trick reflect your planning?
- What modifications did you make during your planning?
- What changes would you make in the future?
- What might pose a problem for this trick?
- What did you learn about perception?
- What did you learn about the interdependence of the senses on perception?

TEACHER NAME		Lesson #
Shaun Thompson		4
MODEL	**CONTENT AREA**	**GRADE LEVEL**
Socratic Seminar	Science	6th-8th

CONCEPTUAL LENS	LESSON TOPIC
Perception	Synesthesia

LEARNING OBJECTIVES *(from State/Local Curriculum)*

7.L.1 Standard:

- Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

http://www.dpi.state.nc.us/docs/curriculum/science/scos/support-tools/new-standards/science/6-8.pdf

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)*
Interdependence influences perception	How does interdependence influence perception?

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… Synesthesia is when one stimulation provokes a sensation of a different sort. Many famous artists have synesthesia, such as Kanye West, Van Gogh, and Hans Zimmer. Researchers are unsure the exact cause of synesthesia, but have linked it to a partial genetic inheritance. There are many forms of synesthesia; synesthesia can occur between any of the senses. Synesthesia may occur because the senses failed to completely separate during early development. All of our senses are interdependent and contribute to our perceptions. Our senses have helped us survive. Evolution favors the traits most helpful for a given situation.	**Students will be able to…** Identify the different kinds of synesthesia. Identify the traits associated with synesthesia. Analyze to determine the importance of having synesthesia. Work collaboratively. Engage in a discussion in which they construct questions and sustain a dialogue. Apply their knowledge of the senses to the life of a person with synesthesia. Evaluate the different "strengths" of the five senses. Prioritize which sense is the most important by applying their knowledge and rationalizing their understanding.

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:

- Which senses are confused? - When have you ever had your senses crossed? - Why do you think this is happening? - Based upon your experiences the last few days, which sense seems to rely more heavily upon another? - Who else might perceive things in a similar manner? - Why are our senses important in regards to perceiving our environment? - How did our senses help us survive?	- What is synesthesia? - What types of synesthesia exist? - How does synesthesia occur? - How would your life be different with synesthesia? - What would you have to change if you had synesthesia? - What is another trait that you find similar to synesthesia? - What professions might this be helpful in? - What professions would this make harder? - How is synesthesia related to perception? - How does synesthesia contradict/confirm what you thought about the senses? - How does interdependence influence perception in terms of survival? - How did the senses aid our survival? - In your opinion and based on your knowledge, which sense is the strongest?	- What was the big theme you noticed throughout the seminar? - Which concepts related back to previous lessons? - What generalizations can you make about synesthesia? - What challenges did this format of group discussion pose for you? - Why did you prefer being in the inner/outer circle? - What are advantages to having synesthesia? (professionally and evolutionarily) - What are the disadvantages to having synesthesia? (professionally and evolutionarily) - How has the role of synesthesia changed from prehistoric days to modern day? - How has our reliance on the senses changed from prehistoric to modern days? - How does interdependence influence perception?

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
Synesthesia is a topic that is not discussed even at the high school level.	Students will think critically in order to create generalizations throughout the seminar portion.		Students are in charge of leading the discussions and monitoring the behavior of each other.

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

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.*

We will start by having the students watch this video, https://www.youtube.com/watch?v=QWil81gl50I, and then describe what they see. What perceptions do you see? What seems to be interdependent? How is this a trick occuring? We will watch it a few times while they think about this and have a short discussion on what they believe is happening. I will then ask them to ponder this "trick" while they perform their own.

Each student group shares the tricks they came up with from the previous class with each of the groups. As each group presents, the students will take notes about what they observed and which perceptions were influenced and how. After each group presents we will have a short class discussion about themes we saw. They should refer back to their notes taken during the presentation. Also, we will discuss which each group thought on what went well, what was hard, and what we think we might change for next time (in regards to their groups coming up with the trick).

Next, students will return to the video I presented earlier (*fictitious example of synesthesia*). I will then ask them the pre-lesson questions to get them starting to think about senses and the interdependence of senses. They will write down their answers and then we will have a group discussion about what they observed.

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.*

https://www.youtube.com/watch?v=4upZHjZnM-0
1) http://www.npr.org/sections/thesalt/2013/03/12/174132392/synesthetes-really-can-taste-the-rainbow
2) https://www.scientificamerican.com/article/what-is-synesthesia/

Students will then watch the above link as brief overview. After that, they will be separated into two groups. Group 1 will receive the first article, and Group 2 will receive the second above article. I will help the students and model what a close reading entails. By close reading, I am referring to reading through the text three times: once to start digesting, twice to make notes and comments, and a third to create open-ended thoughtful questions. The students are instructed to come up with at least five open-ended, higher-order thinking questions by the time they finish close reading their respective text. The questions can also come from the second video they watched as a class.

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.*

When all the students have finished their close reading of the text, I propose some questions to the class:
What is synesthesia?
What types of synesthesia exist?
How does synesthesia occur?
Why do you think synesthesia occurs?
How would your life be different with synesthesia?
What would you have to change if you had synesthesia?
Why don't we see a higher percentage of synesthesia?
What is another trait that you find similar to synesthesia?

The students will take turns answering these questions (volunteers I call on and/or cold calling).

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*

Socratic Seminar - Students then create two circles of equal number of chairs, both facing towards the center. There will be a mix of half of each circle having read article 1 and article 2. The students in the outer circle will be partnered with someone in the inner circle whom they will observe for their participation, as well as make notes on how the conversation is progressing. The inner circle will begin the dialogue, while the outer circle listens, and then after about 15 minutes, the circles will switch positions. Students will already have been briefed about proper dialogue etiquette and be reminded that the outer circle person is critiquing them in both participation and cooperation.

The students then lead the discussion. Some prompts I might use should the conversation falter includes:
How is synesthesia related to perception?
What generalizations can you make about synesthesia?
How does synesthesia contradict/confirm what you thought about the senses?
How does interdependence influence perception?
How reliable is perception?

Explore #2 –

Next, students will be given an article (*I am combining a couple to create the information I want*) that contains information on how each of the five senses aided in our survival as early hominoids. They will repeat what they did with synesthesia by following the rules of close reading, as well as come up with five higher order questions.

Elaborate #2 –

Students will now participate in Socratic Seminar #2. The groups will be split up so it is not all the same people from Group 1 or 2 together in the discussion. The guiding question for this seminar is, which sense is the most important? The students will lead this discussion by themselves with myself as a guide to push them to think of the different advantages evolutionarily of each of the senses.

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

After each groups has a chance in the inner circle, the students return to their seats and answer the following questions as a class:
What was the big theme you noticed throughout the seminar?
How reliable is perception?
Which concepts related back to previous lessons?
What generalizations do you have about the senses?
What challenges did this format of group discussion pose for you?
Why did you prefer being in the inner/outer circle?
How does interdependence influence perception?

After that, I will ask each student to write one sentence that summarizes how interdependence effects perception, which will be collected. Finally, we will discuss any lingering thoughts about the senses and try to answer final questions.

Seminar Questioning Cheat Sheet

Clarification Questions:

- What do you mean by _____?
- What is your main point?
- How does _ relate to ____?
- Could you put that another way?
- What do you think is the main issue here?
- Let me see if I understand you; do you mean __ or ___?
- Jane, would you summarize in your own words what Juan has said?... Juan, is that what you meant?
- Could you give me an example?
- Would this be an example: _____?
- Could you explain that further?
- Could you expand upon that?

Questions About the Initial Question or Issue:

- How can we find out?
- What does this question assume?
- Would _____ put the question differently?
- How could someone settle this question?
- Can we break this question down at all?
- Is the question clear? Do we understand it?
- Is this question easy or hard to answer? Why?
- Does this question ask us to evaluate something?
- Do we all agree that this is the question?
- To answer this question, what question would we have to answer first?
- I'm not sure I understand how you are interpreting the main question at issue.
- Is this the same issue as _?
- How would _____ put this issue?
- Why is this question important?
- Does this question lead to other questions or issues?

Assumption Probes:

- What are you assuming?
- What is Erika assuming?
- What could we assume instead?
- You seem to be assuming _____. Do I understand you correctly?
- All of your reasoning depends on the idea that _____. Why have you based your reasoning on __ ___ rather than _____?
- You seem to be assuming _____. How would you justify taking this for granted?
- Why would someone make this assumption?

Reason and Evidence Probes:

- What would be an example?
- How do you know?
- Why do you think that is true?
- Do you have any evidence for that?
- What difference does that make?
- What are your reasons for saying that?
- What other information do we need?
- Could you explain your reason to use?

Reason and Evidence Probes (continued):

- Are these reasons adequate?
- Can you explain how you logically got from _____ to ___?
- Do you see any difficulties with their reasoning here?
- Why did you say that?
- What led you to that belief?
- How does that apply to this case?
- What would change your mind?
- But is that good evidence to believe that?
- Is there a reason to doubt that evidence?
- Who is in a position to know if that is so?
- What would you say to someone who said _____?
- Can someone else give evidence to support that response?
- By what reasoning did you come to that conclusion?
- How could we find out whether that is true?

Origin or Source Questions:

- Where did you get this idea?
- Do your friends or family feel the same way?
- Has the media influenced you?
- Have you always felt this way?
- What caused you to feel this way?
- Did you originate this idea or get it from someone else?

Implication and Consequence Probes:

- What are you implying by that?
- When you say _____, are you implying _____?
- But if that happened, what else would happen as a result? Why?
- What effect would that have?
- Would that necessarily happen or only probably happen?
- What is the probability of this result?
- What is an alternative?
- If this and this are the case, then what else must also be true?
- If we say that this is unethical, how about that?

Viewpoint Questions:

- You seem to be approaching this issue from _____ perspective. Why have you chosen this rather than that perspective?
- How would other groups/types of people respond? Why? What would influence them?
- How could you answer the objection that _____ would make?
- What might someone who believed _____ think?
- Can/did anyone see this another way?
- What would someone who disagrees say?
- What is an alternative?
- How are Hillary and Tom's ideas alike? Different?

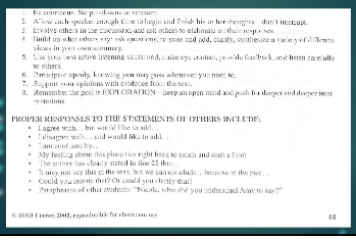
Performance Day!

- What senses are confused?
- Why do you think this is happening?
- Which senses seem to rely more heavily upon one another?
- Why are our sense important in regards to perceiving our environment?

Discussion Time!

- *What is synesthesia?*
- *What types of synesthesia exist?*
- *How does synesthesia occur?*
- *Why do you think synesthesia occurs?*
- *How would your life be different with synesthesia?*
- *What would you have to change if you had synesthesia?*
- *Why don't we see a higher percentage of synesthesia?*
- *What is another trait that you find similar to synesthesia?*

Protocol



1. Be courteous. No put-downs or sarcasm.
2. Allow each speaker enough time to begin and finish his or her thoughts – don't interrupt.
3. Involve others in our discussion and ask others to elaborate on their responses.
4. Build on other others' responses, re-state and add, clarify, synthesize a variety of different views in your own summary.
5. Use your oral active listening skills (nod, make eye contact, provide feedback, and listen empathically to others.
6. Participate openly, knowing you may pass whenever you need to.
7. Support your opinions with evidence from the text.
8. Remember the goal is EXPLORATION – keep an open mind and push for deeper and deeper interpretations.

PROPER RESPONSES TO THE STATEMENTS OF OTHERS INCLUDE:

- I agree with . . . but would like to add. . .
- I disagree with . . . and would like to add. . .
- I am confused by. . .
- My feeling about this place has right here is (touch and feel) a Four
- The author has clearly stated in line 22 that. . .
- I may not say this in the text, but we can conclude . . because in the past. . .
- Could you quote that? Or could you re-say that?
- Paraphrases of other students: "Nicole, what did you understand Amy to say?"

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How is synesthesia related to perception?

How reliable is perception?

Which sense is the most important?

- *What was the big theme you noticed throughout the seminar?*
- *How reliable is perception?*
- *Which concepts related back to previous lessons?*
- *What generalizations do you have about the senses?*
- *What challenges did this format of group discussion pose for you?*
- *Why did you prefer being in the inner/outer circle?*
- *How does the interdependence influence perception?*

Unit Resources

http://www.discoveryeducation.com/teachers/free-lesson-plans/the-incredible-human-body-the-five-senses.cfm

This link provides access to another teacher who has done a unit on the senses designed for older students (high school students). They've included different ways to approach learning about the mechanisms behind the senses by using techniques such as acting out the various parts of a sense.

Yuhas, D. (2012, November 22). Savory Science: Jelly Bean Taste Test. Retrieved from https://www.scientificamerican.com/article/bring-science-home-jelly-bean-taste-smell/

This article had an additional experiment to try in which the students see if they are better at identifying jelly bean flavors with their eyes open or closed.

http://www.iupui.edu/~geni/documents/WorldOnString.pdf

This resource is a different way to show students the concept of interdependence. It allows them to see the connection through a short simulation of a fake community.

Greenwood, V. (2014, December 15). How to Hack Your Tastebuds. Retrieved from http://www.bbc.com/future/story/20141214-how-to-hack-your-taste-buds

This resource explains how the miracle fruit tablet works. It also goes deeper into why when you eat two things back to back, the second one tastes worse – like orange juice after toothpaste.

Groeger, L. (2012, February 28). Making Sense of the World, Several Senses at a Time. Retrieved from https://www.scientificamerican.com/article/making-sense-world-sveral-senses-at-time/

This article talks about how people without a specific sense (blind, deaf, etc.) often have more developed other senses. This will give a good background on how strong some people's senses can become.

Rosenblum, L. (2011). The Exotic Sensory Capabilities of Humans. Retrieved from https://thepsychologist.bps.org.uk/volume-25/edition-12/exotic-sensory-capabilities-humans

This article talks about the underutilized capabilities of humans, specifically echolocation. The author looks into several cases where people have been able to develop minor forms of echolocation and how this is possible.

http://faculty.washington.edu/chudler/introb.html#se

While many of the activities on this page are too simple for gifted students, many can be modified to look at the senses in a different light that is still academically challenging.

Downey, G. (2011, June 14). Getting around by Sound. Retrieved from http://blogs.plos.org/neuroanthropology/2011/06/14/getting-around-by-sound-human-echolocation/

This is another article on human echolocation, but with more about how you can conduct echolocation experiments in the classroom as well. This is a good supplemental if you have the time to allow the students to try to develop or experiment with a rudimentary version of echolocation.

https://thehearinghouse.com/hearing-and-balance

This website has a lot of information on hearing and balance. While hearing is a sense, balance is kind of a sense in terms of touch as proprioceptors do make up part of the sense of touch. This article explains more in depth about how balance and hearing are related. It also has various ways in which balance can be affected.

https://www.newscientist.com/article/dn16809-body-illusions-rubber-hand-illusion/

This website includes an illusion that would be another great experience for the students to have. This involves the sense of touch and the sense of sight, and it tricks the body into thinking their hand is the fake hand in front of them. They really enjoy this one if you can find the time.

Curnoe, D. (2015, July 13). Making sense of our evolution. Retrieved from http://theconversation.com/making-sense-of-our-evolution-44591

This article talks about the evolution of our senses. This is useful if the students are more interested in how our senses came to be. It also compares the sensory adaptations some of the now-extinct hominoids had, such as the nose on the Neanderthal.

https://www.ted.com/talks/david_eagleman_can_we_create_new_senses_for_humans

This is a TED Talk where the person discusses the idea of new senses for humans. Many students enjoy listening to TED Talks so this is another way to keep them engaged. It would also be a good follow up if you had them before watching this to try and imagine suddenly having a 6th sense and what that sense would be.

Masland, R. H., & Albright, T. (2008). The senses: a comprehensive reference (1st ed.). Amsterdam: Boston.

With this book, you should not have any more questions about how the senses work. This is the most complete overview of the senses thus far covering biological and psychological aspects.

Cole, B. (2016, June 10). The Weirdest Senses Animals Have That You Don't. Retrieved from https://www.wired.com/2016/06/weirdest-senses-animals-humans-dont/

This is a really neat article about senses that other animals have that we humans do not. It is a great supplemental reading for students who get really interested in know what other senses exist and how other animals use their senses.