

Wildlife, Plants, and Habitats of the Southwest

Natural Elements and Cycles: Cycling in Matter

Kim Etsitty

Diné Institute for Navajo Educators (DINÉ)

2022

Author Note:

Kim Etsitty, seventh and eighth grade teacher at Tsehootsooi Middle School, Correspondence about this curriculum unit can be addressed to Kim Etsitty. P.O. Box 312, Window Rock, AZ, 86515. Email contact: kimetsitty@gmail.

“It is believed that centuries ago the Holy People taught the Diné how to live the right way and to conduct their many acts of everyday life. They were taught to live in harmony with Mother Earth, Father Sky and the many other elements such as man, animals, plants, and insects. The Holy People put four sacred mountains in four different directions, Mt. Blanca to the east, Mt. Taylor to the south, San Francisco Peak to the west and Mt Hesperus to the north near Durango, Colorado, thus creating Navajoland” –Ray Baldwin Lewis (*Navajo Culture – Discover Navajo*, 2000)

Introduction

This unit is on the cycles in matter. It will provide insight into how Indigenous science is naturally embedded in cycles of elements on earth and the universe. Understanding the basic elements of life and how they move in cycles can help better understand the ecosystem. The Navajo Nation resides in the four-corner region in the great southwest, this means that we experience the four seasons spring, summer, autumn, and winter.

With seasons comes precipitation at different temperatures and forms. Living in Chinle, AZ also known as the central agency of the Navajo Nation I have witnessed a vast amount of rain some years whereas little or no rain most years. As a kid, the best memories were the years when we had a wet year. Seeing the water rush down Canyon De Chelly and flowing its way through the local washes was mesmerizing yet frightening. During the monsoon season, the water became aggressive by washing away the culverts and roadways to relatives' homes. At the time, I had no understanding that the water moving in such a way was unnatural because most of the water rushing through the washes was leaving the land due to erosion. Ch'íníłí is the Navajo name for Chinle which means “flowing out” and that is exactly what happens with the water. Over the years the channel of the water has become narrow due to many factors and this has put a negative effect on local corn fields and native plant species such as cottonwood. The water cycle of the Navajo land has not only been disturbed but also ignored. With this curriculum, I plan on teaching about the natural elements as well as the cycles such as the water, nitrogen, and carbon cycle from an Indigenous perspective as well as a western scientific point of view.

Context

Geography and Community Demographics

I teach 7th and 8th-grade science at a state-funded school located in Fort Defiance, AZ which is part of the southern region of the Navajo Nation. The southern region consists of the states of Arizona and New Mexico meaning that our school district has students enrolled that reside in Arizona or New Mexico. The Navajo Nation is a unique place when it comes to its topography. Nearby we have mountains that stretch for miles and peak at 10,000ft, canyons down the road with walls with a height of 800ft, volcanic necks that reach 7,177 ft above sea level, and so on. Each of these unique landforms can be visited in a short amount of time depending on where you are. For example, living in Fort Defiance, I can either drive thirty minutes to the peak of the Chuska Mountain, one hour to see the scenic views of Canyon De Chelly, or a little over an hour

to Shiprock's volcanic neck. The beauty and the culture that goes along with each landform are breathtaking; according to new research states that tourism alone has the potential of generating a substantial amount of income for the Navajo Nation (*Tourism – NN DED*, n.d.).

At the elevation of 6,836 feet where the pinyon trees meet the ponderosa pine sits a community of 3,525 people (Census, 2021). According to the 2020 U.S. Census, there are 770 families and 1,167 households that reside in Fort Defiance, AZ. Of the 3,525 people, the majority are Native American (Navajo) which make up 88.74% (U.S. Census Bureau, n.d.). The remaining racial compositions of the population are 3.35% White, 1.62% African American, 1.54% Asian, and 3.94% from two or more races

The small community includes three stoplight intersections, one with two gas stations and another with a hospital. A town that stretches 6.41 square miles serves the people with a laundry mat, one fast food restaurant, a fitness center, three schools, one daycare, a car wash, and at least four different churches. With such a small amount of businesses in the town, the people can travel six miles south to Window Rock, AZ to get their essential needs at the local grocery store or travel twenty-five miles to the nearest border town. Towns like Fort Defiance, AZ are similar throughout the Navajo Nation and that is what makes living on the reservation unique. Unique because the reservation may not offer a lot but having a wide range of open land creates room for adventure. Adventures vary from learning how to drive by practicing on the dirt roads that lead towards the sunset or learning how to plant with your grandparents while all your cousins wrestle in the wet dirt on a hot summer day. These are some of the few memories one can hold dearly yet relate to throughout the Navajo land.

History of Fort Defiance

I have been an educator for ten years and this will be my fourth year teaching 7th and 8th grade at Tséhootsooí Middle School located in Fort Defiance, AZ. Before transforming into present-day Fort Defiance, this little town was occupied by the great-great-grandparents of the residents for hundreds of years. The Navajo people occupied the nearby canyons that provide breathtaking views from the pinion trees along the jagged rocks, this town known as Fort Defiance, AZ is better known by the Navajo people as Tséhootsooí. I will give a brief history of how the Diné people persevered and battled to continue to occupy the land they call home. I feel this is important because this history can be shared with current students within the area to build a foundation for their self-identity and sense of belonging.

Raiding

Fort Defiance, AZ has a rich history that began in the fall of 1851. The history that comes with the location can be told from two different perspectives. One is a colonial viewpoint and the other is derived from traditional knowledge and oral stories from our Navajo (Diné) people. I will give a brief narrative on the colonial viewpoint that started in the mid-1850s. Fort Defiance was first noticed by a United States Colonel that goes by the name of John Washington in the late 1840s, from my understandings he was making his way through the land coming from Canyon De Chelly (*Fort Defiance, Arizona – Watching the Navajo – Legends of America*, n.d.). Canyon De Chelly is located in Chinle, AZ, and is roughly 60 miles away from Fort Defiance. At

the time there was no military base in the Navajo area and the Navajo people were constantly raiding and resisting the government. They demonstrated this by raiding army troops and breaking the treaties against the government repeatedly. When the United States ended the war with Mexico also known as the Mexican Cession, the urge to manage the Navajo people was encouraged (*Fort Defiance, Arizona – Watching the Navajo – Legends of America*, n.d.).

Meadow between Two Rocks

In 1851, Fort Defiance was established as a fortress by United States Colonel Edwin V. Sumner. The Navajo people referred to the land as Tséhootsooí which meant the meadow between two rocks. The interpretation of the name was accurate because the land was held for grazing livestock by the Navajo people. Once utilized and managed by the United States troops battles began because the Navajo people were no longer able to use the land for grazing. With two cultures clashing and the United States refusing the right to utilize that land, the feud became intense. According to the article, watching the Navajo it states although the Navajo people were upset, they eventually accepted the military outpost and got along with the United States soldiers by participating in various horse races. Unfortunately, it did not last long due to an incident in which the United States soldiers cheated and once again the Navajo people were upset resulting in a battle where 30 Navajos died (*Fort Defiance, Arizona – Watching the Navajo – Legends of America*, n.d.).

Abandonment

With that event happening and the loss of many Navajos, the Navajo people became angry and the raiding and fighting continued against the United States government. The trust was broken and the rage flourished throughout the Navajo land and did not stop. In 1860, a war was ignited against the fort with over one thousand Navajo warriors in attendance. The Diné warriors were led by two leaders by the names of Manuelito and Barboncito, the battle was successful for a moment until the troops led by Captain O.L. Shepherd were able to attack and chase the warriors away (*Fort Defiance, Arizona – Watching the Navajo – Legends of America*, n.d.). During this time in the United States, multiple battles were occurring with the most famous being the Civil War. Once the Civil War began in 1861, Fort Defiance became abandoned and the troops moved to present-day Fort Wingate but the absence of the soldiers did not last long. Although the fort was abandoned, the Navajo people were still supervised by Brigadier General James H. Carleton who is known for saying, “All Indian men of that tribe are to be killed whenever and wherever you can find them.... If the Indians send in a flag of truce say to the bearer ... that you have been sent to punish them for their treachery and their crimes. That you have no power to make peace, that you are there to kill them wherever you can find them.” (Carleton, 1814-1873) With this mindset, you can imagine the type of methods he would use to control the Navajo people. I use the word control because at the time the Navajo people were tired of being mistreated by the United States Calvary and had continued to resist and fought their way to keep their culture and land as is. With the raiding continuously happening and rebellious acts against both parties General James Carleton sent in Kit Carson to inflict order to have our Navajo people surrender.

Fort Canby

In 1863, the Fort was reestablished as Fort Canby with Kit Carson in charge with the orders of General James Carleton. General James Carleton was known to have ruthless tactics to remove Indian people (Balance, 1814-1873). The Navajo people had resisted against the United States government for 250 years with multiple U.S. Colonels and Generals failing each time. Now that Kit Carson was in charge he followed the intense and aggressive campaigns that General J. Carleton had ordered which were known as the Scorched Earth Policy. The Scorched Earth Policy is a term used by the military that refers to eliminating all natural resources so the attackers have limited resources to survive (*Scorched Earth Policy - Explained*, n.d.). The Navajo people fled to the mountains, canyons, and hiding spots because the United States soldiers were showing no mercy. The goal was to round up all the Navajo people and remove them from the land. After days of burning down crops, hogans, and death to many of the livestock, the Navajo people surrendered in Fort Defiance.

Hwéeldi

In 1864, more than 9,000 men, women, and children were rounded up from the Navajo region which resides in Eastern Arizona and Western New Mexico. Fort Defiance was a place where the Navajo people were held and imprisoned similar to a concentration camp. In the winter of January 1864, the trauma began once more known as the “Long Walk” (n.d.). The Navajo people were forced to walk in winter cold conditions to Fort Sumner, NM a 300-mile walk. In the Navajo language, Fort Sumner, NM is referred to as Hwéeldi meaning a place of suffering and fear. Hwéeldi was indeed a place of suffering losing as many lives as 300 Navajos from illnesses and starvation.

1868

Naaltsoos Sání also known as the “Old Paper” was the treaty that allowed the Navajo people to return home after four years of torment in Bosque Redondo. It was signed by the United States Government and Navajo Leaders. The treaty indeed allowed the Navajo people to return home but with obligations such as accepting western education for the children by sending them to boarding schools. The boarding schools were operated by the missionaries; the goal of education at the time was not to educate but to eliminate self-identity by forbidding the Navajo language and culture. The schools were similar to a military structure where the students were a force to wear uniforms and march from one area to another. This type of education lasted generation after generation up to the 1970s.

Home of the Scouts

Coming home after the treaty of 1868 and accepting education allowed the trauma to continue because Navajo children would have to leave home to boarding schools and become assimilated into American culture. In 1954, one of the first public schools in the Navajo Nation opened up in Fort Defiance, AZ. The goal was to serve Navajo families and allow students to remain on the reservation for school and receive a quality education. Although the enrollment started small it began to increase over time. The first graduating class of Window Rock School District was in 1958 with twelve students receiving their high school diplomas. Window Rock School district is home to the Scouts which they currently serve one thousand eight hundred sixteen students.

Rationale

The curriculum I dream of is more than academic learning; it is to build self-identity and curiosity about the natural world through natural cycles. One thing I have learned about myself is when it is possible to share meaningful knowledge of Diné teachings and relate it to the content, I become passionate. It is when I am passionate, that the students can then see and hear the importance of the lesson. I have observed and seen through the interaction of the activities that the students obtain the objective through questioning. I kindly remind my students that living in the Navajo Nation is unique and beautiful and that they should be proud to be here. Learning about the habitats and wildlife in the area can allow them to appreciate their environment and have respect for the natural world.

I teach at a public school where the curriculum materials are provided by the Arizona Department of Education. The curriculum mapping is ultimately determined by each department within the school. As the head science teacher, I have laid out the pacing guide and mapping of the standards in a way that builds up to the larger concepts.

As an educator, I have spent numerous hours with my students having meaningful discussions, asking higher-order thinking questions, giving immediate feedback, and working one and one, and I can give formal and informal assessment data proving that they are acquiring the content from the classroom. Yet the state assessment is labeling them as non-proficient or performing below average which can often feel devalued as a teacher and most of all to the student. There are more than 1,111,000 students that attend public schools in Arizona and creating a single standardized test that measures their intelligence is not only unfair but culturally unresponsive. It is culturally unresponsive because 37.05% are white, 45% are Hispanic, 2.8% are Asian, 5.18% are African America, 4.1% are Native American, 0.3% are Pacific Islanders, and 5.13% are of multiple races. The pressure of teachers enforcing strategy after strategy as well as meeting the needs of all the students when the state cannot do the same by creating multiple testing to meet the needs of students of different backgrounds is frustrating. Unfortunately, when it does come to being culturally responsive the school or teacher becomes a target. For example, in 2008 Tucson Unified School District was battling the former state superintendent, Tom Horne, who believed the Mexican American Studies (MAS) program was meant to indoctrinate students and create hatred for other races by breeding ethnic solidarity. Resulting in 2010, the newly appointed Arizona Governor, HB2281 was signed and passed, banning the MAS program (Gonzalez, 2020). They banned books in Arizona public schools that taught American history from a Mexican perspective. The state reasoned that the books were teaching reverse racism and teaching hate against the United States. If the curriculum of education is set to one viewpoint, is education at all? It is not allowing students to think critically, it is a form of indoctrination.

As a science teacher, I have noticed a disconnection when it comes to Native students and western science. Many of my students do not see themselves as a part of the ecosystem and the problem with the mainstream curriculum is that it seems to isolate science phenomena rather than be a part of them. Every year I ask my students if they can name at least five Indigenous scientists, and unfortunately, they are unable to. The need for Indigenous scientists is in high demand because the amount of traditional ecological knowledge is vast.

In the article Understanding Yurok traditional ecological knowledge and wildlife management it states that by bridging concepts from Indigenous studies, wildlife management, and human dimensions of wildlife, this work may serve as a nascent trajectory that creates more inclusive space for Indigenous peoples and worldviews in The Wildlife Society and other scientific disciplines. The curriculum will aim to demonstrate how the Diné way of life can be incorporated into daily activities through nature. When I mention nature, I want to focus on natural cycles and elements such as the hydraulic, carbon, and nitrogen cycle. I decided to focus on these science concepts because they scaffold the standards from quarters one and two. Also, my students will have the prerequisites of the building blocks of life, atoms, and cells.

For as long as I can remember, the Navajo Nation has been facing many environmental issues from overgrazing, illegal dumping, drought, mineral, and other natural resource extractions. These environmental concerns on the Navajo Nation have been addressed by the Navajo Nation government but the lack of action has yet to come. The process of actions seems to happen in a manner that takes longer than usual. As an educator, I want to create a curriculum that encourages students to appreciate the environment and also consider becoming an Indigenous scientists.

The goal of this unit is that when I approach this topic in a worldview that is Diné, there will be a deeper meaning of self and respect for the environment. Not only do I want my students to be observant of nature but also to be a participant in nature. The Indigenous science experience is not only evident through songs and stories but also intimate expressions of individual acts of respect and care for the world. In the curriculum, Diné oral stories, and literature will be presented when introducing the key elements and vocabulary. The unit will take two weeks and consist of guest speakers, Google slides, and labs.

Classroom Demographics

Although the district I work for is called Window Rock School District, five of its six schools are located in Fort Defiance, AZ. According to U.S. News Today the district serves 1, 816 students with 99% American Indian or Alaskan Native, followed by 0.1% White, 0.1% Black, 0.2% Asian or Asian/Pacific Islander, 0.6% Hispanic/Latino, 0.1% Native Hawaiian or other Pacific Islander. In addition, 0.1% of students are of two or more races, and 0% have not specified their race or ethnicity (*Overview of Window Rock Unified District*, 2019). To add to the statistics 29.6% of students are eligible to participate in the federal free and reduced-price meal program. To qualify for the reduced lunch program households need to meet the Federal income poverty guideline and this may differ amongst the size of the family.

Although, five of their six schools are located in Fort Defiance, we have one school in particular that is located in the heart of Window Rock, AZ. The school is a Navajo Language Immersion school called Diné Bi'Olta which means Navajo School. It serves students kindergarten to sixth grade and its primary focus is to learn the Navajo Language.

I have been a Structure English Immersion (SEI) teacher before and I understand that when a student enrolls and the parent/guardian checks the box stating if there is another language spoken in the home that is not English the child is automatically referred as an English Language Learner (ELL). Although the students may not speak the language nor understand it, he or she will be labeled as ELL. Teaching at the middle school, I realized fast that a lot of these students who were labeled ELL indeed speak and understand a language other than English.

Of the 1,816 students 12.5% are English Language Learners which means that 228 students are at home hearing or speaking another language other than English. To me this is not a surprise because a lot of the incoming sixth graders that came from Diné Bi'Olta were fluent writers and readers of the Navajo language. When I moved up to teach middle school, I noticed that many of the students that had attended Diné Bi'Olta carried this pride of speaking Navajo. As a Navajo educator, seeing this was a beautiful thing because often students feel embarrassed to speak Navajo because they feel like it is correlated to growing up in poverty. One factor that I feel that played a role in building up such pride is the partnership Diné Bi'Olta had with the Navajo Nation Museum. In 2016, Manuelito Wheeler the director of the museum had joined efforts with The Walt Disney Studios to translate Finding Nemo in Navajo. Finding young Navajo speakers was scarce but not at Diné Bi'Olta. A lot of the characters casted to dub Finding Nemo were from the Navajo immersion school and that was something remarkable. I remember my students sharing who played which role and how memorable the experience was. Hearing their laughter and stories of their experience was not only funny but uplifting. It was uplifting because it became hopeful that the next generations will have fluent Navajo speakers.

Window Rock School District gathers its' academic data through two assessment platforms known as the Northwest Evaluation Associate (NWEA), and Arizona's Academic Standards Assessment (AASA). According to the state data from 2017-2018 the district averages a proficiency rate of 25% passing rate for mathematics and a 27% passing rate for reading with a 80.7% high school graduation rate (*Overview of Window Rock Unified District, 2019*). The table below shows the current NWEA data from my current class.

7 th Grade	Lo	LoAvg	Avg	HiAvg	Hi
Physical Science	10	16	12	6	0
Life Science	15	9	9	10	1
Earth and Space	15	11	11	5	2
Total Students	40	36	32	21	3

8 th Grade	Lo	LoAvg	Avg	HiAvg	Hi
Physical Science	19	7	11	4	0

Life Science	19	12	4	5	2
Earth and Space	16	12	10	3	1
Total Students	54	31	25	12	3

Although the NWEA data does not correlate with state testing, it is clear see that students are obtaining new knowledge so our questions as educators become how the state assessments best suit our students.

Content Objective

What are elements?

In science class, when the word element is mentioned most people will think of the periodic table. Scientifically, elements are the basic part of a whole. It is a simple substance that cannot be broken down into smaller parts (*NCI Dictionary of Cancer Terms*, n.d.). Atoms make up the elements and depending on their atomic mass will consist of a different number of protons, neutrons, and electrons. Elements make up matter, and matter is anything that takes up space such as gas, liquid, solid, or plasma. There are one hundred eighteen elements in the known universe and according to French chemist, Antoine Lavoisier, states that matter cannot be destroyed nor created in a closed space. This concept is known as the Law of Conservation of Mass. This law is important when it comes to learning about how energy cycles flow. Understanding the fundamentals of chemistry from the structure of an atom to how they bond to create molecules to macromolecules to create life can lead to a strong foundation for how the universe works.

When outside the classroom and amongst Indigenous peoples the word element can be described as fire or light, earth, water, and air. Depending on the culture, elements in the Indigenous culture come in fours. In Navajo culture, the four elements are light, water, air, and earth. They serve as our mother and father, for example, air and fire are considered the female elements or the negative elements whereas earth and water are the positive elements or the male elements. When combined they create balance and life for all living things (U.S. Census Bureau, n.d.-b). This concept of pairs or the duality of objects can often be referred to as “Sa’ah Naaghai Bik’eh Hozhoo” by the Navajo people. It is the philosophy that guides and organizes our thought process. It is the traditional living system that helps place life in harmony with the natural world and the universe. It is the process of learning and reflecting through daily cycles of day and night. The philosophy that organizes the thought process is known as the Sa’ah Naaghai Bik’eh Hozhoo paradigm or SNBH paradigm; it utilizes the four cardinal directions as a way to put the elements into order. It begins with the east direction clockwise to the north; in each direction, four sacred colors represent the four sacred mountains. The four sacred mountains starting with the east are Sisnaajini (Blanca Peak in Colorado), Tsoodzil (Mt. Taylor in New Mexico), Dook’o’ooslid (San Francisco Peaks in Arizona), and Dibe Nitsaa (Hesperus Peak in Colorado). The four directions along with the four sacred mountains symbolize an immense amount of knowledge, teachings, prayers, songs, and so on. Sa’ah Naaghai Bik’eh Hozhoo, is embedded

within the four sacred mountains and directions. It starts in the early morning dawn when it is white and glistening outside, you think (Nitsahakees) and pray about what you want and need to accomplish to the east. Next, when the skies become blue you start speaking about your plans (Nahata) and the purpose. As the yellow evening twilight arrives, that is when you are living (Iiná) and acting on your plans. Finally, the darkness arrives, and you lie down before you go to bed this is the stage of reflecting (Siihasin). Through this thought process, I plan on incorporating the SNBH within my curriculum when speaking about the elements and how they flow within their cycles to help students understand that elements of our planet are the same elements that make up our bodies.

How do elements and cycles work together?

According to the Law of Conservation of Mass, matter does not get created nor destroyed. For example, the four elements carbon, nitrogen, phosphorus, and sulfur are constantly moving and changing within the biogeochemical cycle. The biogeochemical cycle is also known as the nutrient cycle because they are responsible for keeping the four elements available for all living organisms. The biogeochemical cycles that I will be teaching in my classroom are the water, carbon, and nitrogen cycles that occur in the biosphere. The biosphere is the layer of earth where life exists, in science terms, three components make this up which are the lithosphere (soil), hydrosphere (water), and atmosphere (air) (*Intro to Biogeochemical Cycles (Article)*, n.d.). The atoms have ventured through the biosphere for billions of years allowing energy to flow through the ecosystem. Changing their molecular shape but never disappearing, these elements are responsible for the ever-flowing cycles of our universe.

Water Cycle

Water is life. It is the most important molecule for all living things. Our bodies consist of trillions of cells; these cells contain more than 70% of water meaning we are made of water. The emphasis on the phrase “Water is Life” amongst the Indigenous people community has become a political movement for the right to clean water and protect our water. In 2016, thousands of people across the country joined in solidarity with Standing Rock (*Standing Rock Sioux and Dakota Access Pipeline | Teacher Resource*). This protest was to oppose a pipeline to be built through the sacred land of the Sioux Nation. The Dakota Access Pipeline protest was a tragic event, the Indigenous people fought to keep their river clean by refraining from a pipeline being built beneath it. This type of injustice is known as environmental racism because the companies that want the natural resources and minerals of the earth are not considering the people of the land and seeking only prophets for themselves.

A water molecule is made up of two hydrogen atoms and one oxygen atom. This molecule resides in our body and exits either through our respiratory tract, gastrointestinal tract, through our skin, or kidneys. Depending on how the water molecule exits, its journey will continue. If exited through sweat, the water molecule will evaporate into the air as a gas. The gas molecules of water will accumulate through evaporation from oceans, rivers, and lakes. Once enough water vapor reaches the atmosphere it will condense into a cloud this is called condensation. With an abundant number of clouds, precipitation also known as rain, snow, or sleet depending on the temperature of the air will occur. As the rain falls back to earth the

journey of the water droplet can vary in the cycle. If it makes it to a body of water it can reheat and change its state back to gas and restarts its process back to the clouds. If it ends up on the earth's surface, it can infiltrate the soil nourish plants, or permeate into the ground creating an aquifer. Humans and animals will consume the water and release it back into the air and the cycle is repeated.

According to new research, we have less than 3% of fresh water on earth (*Earth's Freshwater* | *National Geographic Society*, 2020), therefore it is important to teach about the natural element that sustains life for all.

Carbon Cycle

The carbon cycle can be studied in two unified sub-cycles; one about carbon atoms moving rapidly amongst the biosphere and the other occurring millions of years within the geosphere.

Carbon that is occurring within the biosphere moves swiftly from humans and animals through respiration. Sadly, human emissions have been a huge concern in the carbon cycle because the amount of carbon dioxide produced has created an imbalance. Too much of anything can be a problem, having too much carbon in our atmosphere has resulted from the earth warming up. The slightest temperature change can put unique plants and animal communities in danger. Organically, carbon enters all food webs of the ecosystem. Self-feeders such as plants or algae capture carbon dioxide through the air and proceed to the process known as photosynthesis making glucose or sugar allowing animals and humans to consume it. Once consumed by either organism, cellular respiration will begin the process of breaking down the carbon molecules within the sugar then released as carbon dioxide. This natural process has been imbalanced due to the industrial revolution and the high need for fossil fuels.

In the geosphere, fossil fuels formed from the remains of prehistoric plants and animals create oil, coal, and natural gas. This process takes millions of years. Since the early 1900s, the need for fossil fuels and human activity has increased the amount of carbon dioxide in our atmosphere. When fossil fuels are burned, they are released into the atmosphere as carbon dioxide. Carbon dioxide is a greenhouse gas that can trap heat. This is a natural part of the carbon cycle but due to deforestation a large amount of carbon dioxide cannot be used for photosynthesis.

Nitrogen Cycle

Nitrogen is a key piece of all living organisms. We would not be here without nitrogen. The nitrogen atom makes up our genetic blueprint that is responsible for all the proteins that make up our body. We consume nitrogen through the food we eat. It exists in plants and animals because they are also made from proteins.

The nitrogen cycle is complex; to start it off I will begin at the atmospheric level where most of the nitrogen is found. A storm arises and lightening is struck, through the lightning nitrogen travels and ends up in the soil. The soil is a large reservoir of nitrogen. The bacteria in the soil are important for nitrogen fixation which makes the nitrogen useable for plants. Through assimilation, the nitrogen is now within a live plant that can be passed into a human or animal.

With our bodies consisting of DNA (deoxyribonucleic acid) and needing nitrogen for protein, we will consume plants for nourishment. Once passed through the digestive system, the nitrogen has become excreted through waste. The waste that decomposes returns nutrients to the soil and is often used as a fertilizer for plants to grow. Man-made fertilizers contain nitrogen and can help get a higher crop yield but surface runoff containing fertilizer can be toxic in high amounts. Usually, nitrogen is found in fertilizers in the form of ammonium, which makes it more easily usable by plants. Nitrogen in surface water can move to the ocean through the process of runoff, the flow of water from the surface to rivers, streams, lakes, oceans, and other bodies of water. This runoff takes the nitrogen in the surface water with it. Often the nitrogen in the rainwater or surface water will seep into the groundwater and travel to either ocean water or surface water. This cycle will then repeat itself time and time again.

Teaching Strategies

Frayer's Model: This is a graphic organizer used to help students acquire new vocabulary (2018). The graphic organizer focuses on one word at a time. The word focus is usually written in an oval at the center of the graphic organizer. The graphic organizer consists of four squares. Each quadrant will be blank and have a heading that gives the task of either defining the term, utilizing it in a sentence, illustrating, example, non-example, syllables, prior knowledge of word or parts of speech. Depending on the word, I often decide on at least two tasks they must complete and allow them a choice by choosing their two remaining squares.

Effective Lecturing: This teaching strategy engages the learner by presenting the content through social interaction. Although videos, pictures, and reading materials are available, live instruction has always been more meaningful for me. This is where I will introduce and review the vocabulary, with science being a passion of mine; I feel this technique plays a strong role in my teaching. This is where I can include stories and the relevance of our surroundings and tie it into the content and objectives. Utilizing effective lecturing is intimate because you can see the students' expressions of confusion, disinterest, or excitement about the lecture (2022).

Implementing Technology in Instruction: To ensure that the students can see how the different cycles operate, videos and interactive diagrams will be shown on the SmartBoard. Stimulating the students through animations and visuals will give an alternative representation of the content. Implementing technology can lead to higher engagement and lead a better understanding of the content (Murphy, 2016). The students will also utilize laptops to create Google slides.

Turn and Talk: This allows the students to explain their thoughts and have discussions with their peers. Turn and talk occur in pairs. Often the teacher will present a question to the class and set a timer for fifteen-twenty seconds, once the signal is made, the students will start sharing their answers. Once the timer ends, the teacher can either choose randomly or cold call a student to elaborate on their answer.

Guest Presenters: As an educator, I have learned that when bringing the outside world inside the classroom; can have a positive effect on the learners. For example, when I taught second grade in Phoenix, AZ, I was covering a unit on habitats and living down the road from the Arizona Bird store I decided to reach out and ask if they could bring some of their birds to my classroom.

Fortunately, they were happy to network with me and make that possible. I remember seeing the delight and excitement on my students' faces. Since then I have been incorporating guest presenters in my classroom and for this unit, I will network with the Navajo Tribal Utility Authority to talk about the water cycle in the Navajo Nation as well as the Carbon Cycle.

Classroom Activities:

Daily Objectives:

Week 1

Day	Student Friendly Objective
1	Pre- Assessment and Introduction- I can take a pre-assessment on how matter moves within an ecosystem.
2	I can use the Frayer's Model to define the following vocabulary. -atmosphere, geosphere, hydrosphere, matter, energy, precipitation, transpiration, condensation, evaporation
3	I can use the SNBH paradigm to guide the flow of the water cycle using the appropriate science terms on Google slide.
4	I can use the SNBH paradigm to guide the flow of the water cycle using the appropriate science terms on Google slide.
5	I can present my water cycle diagram and self evaluate using the friendly student rubric.

Week 2

Day	Student Friendly Objective
1	I can use the Frayer's Model to define the following vocabulary. - carbon, photosynthesis, fossil fuels, decomposition and green house gases
2	I can illustrate a landscape that I am familiar with the following components; water reservoir, animals, fossils, plants, cars, atmosphere, geosphere, and volcano
3	I can use the SNBH paradigm to guide the flow of the carbon cycle using the appropriate science terms on my illustration.
4	I can use the Frayer's Model to define the following vocabulary. -nitrogen fixation, nitrification, denitrification, bacteria, assimilation, leach, and decompose
5	I will explore the Nitrogen Cycle by modeling the movement of a nitrogen atom as it passes through the cycle.

Week 1:

Pre-Assessment:

Before introducing the vocabulary or the content, a pre-assessment will be administered to see how much prior knowledge they have as well as their learning style. The pre-assessment will allow me to also see the strengths and weaknesses of the class as a whole. The assessment provided will be a paper and pencil task.

Pre-assessment

Directions: Read and answer each question with yes or no.

	YES	NO
1. The water cycle begins with evaporation.		
2. When the Sun heats up the puddle of water in your backyard and turns it into water vapor, this process is known as condensation.		
3. The water cycle is Earth's way of recycling water.		
4. The water in lakes, rivers, streams and swamps can have bacteria and other things in it that can make you sick if you drink it.		
5. The water in lakes, rivers, streams and swamps must be cleaned before it is safe for you to drink.		
6. Impurities in the water of lakes, rivers, streams and swamps make it look and smell bad.		
7. Clouds are a large collection of very tiny droplets of water.		
8. Clouds are white because they reflect the light of the sun.		
9. A cloud forms when air is heated by the sun.		
10. An aquifer is an underground formation that is able to store water.		
11. Drinking water can come from an aquifer.		
12. Pollution can go through the ground and get into water we drink.		
13. Water makes up between 55-78% of a human's body weight.		
14. The carbon cycle includes both living and nonliving things.		
15. Carbon changes form as it moves through the carbon cycle		
16. Volcanic eruptions release carbon dioxide into the air.		
17. The atmosphere contains more carbon than the ocean.		
18. Carbon cycles very quickly through ocean water.		
19. Nitrogen is one of the most important nutrients needed by plants.		
20. Plants obtain nitrogen directly from the atmosphere.		

21. Nitrogen in runoff that enters ponds kill algae and water plants.		
22. When algae use food for energy, they release oxygen into the water.		
23. There is a large dead zone in the Gulf of Mexico.		
24. I work better independently.		
25. I am knowledgeable in the water cycle.		
26. I am knowledgeable in the carbon cycle.		
27. I am knowledgeable in the nitrogen cycle.		

Water Cycle Activity

Lesson Objective: I can use the SNBH paradigm to guide the flow of the water cycle using the appropriate science terms.

Goals: Student will describe/ demonstrate the movement of a water drop through the water cycle.
The

Diné character building: I will apply and practice the Diné way of life through planning.

Key Vocabulary: atmosphere, geosphere, hydrosphere, matter, energy, precipitation, transpiration, condensation, evaporation, solar radiation

Anticipatory Set: Video: [Water Cycle Video](#) -Turn and Talk

Lesson Procedure:

1. Review Vocabulary
2. Introduce the Water Cycle using the SNBH Paradigm- Effective Lecture (15-20 min.)

Class discussion

- What are elements?
- What are biogeochemical cycles?

-How do elements and cycles work together?

-How does it create life?

3. Teacher will present assignment along with rubric. There are three options for modeling the water cycle.

Option I: Create a comic strip with a molecule of water as the main character.

- a. The comic must include text that explains what is happening in each frame.
- b. The text can be dialogue 'spoken' by the drop or written as captions at the bottom of the frame.
- c. Include terms from the SNBH paradigm.

Option II: Create a technology presentation with a diagram of the water cycle

- a. It needs to have a water drop moving from one step to another.
- b. Each step in the cycle must have text that describes what is happening to the drop. The text can be dialogue 'spoken' by the drop or written as captions near the drop.
- c. Include terms from the SNBH paradigm.

Option III: Create a model of the water cycle using clay.

- a. It needs to a high and low terrain.
- b. It needs to have a water path way (stream, or creek)
- c. It needs to have recycle materials that mimic the land such as cloth for plants
absorption or hard surface for land.
- d. Include terms from the SNBH paradigm.

4. Students will describe/ demonstrate the movement of a water drop through the water cycle. The water drop may begin anywhere in the cycle and must go through at least two phase changes. The project may also include how gravity and the sun's heat (energy) drive the cycle.

5. Student will self-assess using rubric.

Closure: The teacher will end the lesson with the following; [How off-the-grid Navajo residents are getting running water.](#)

Post Assessment: Students will use the SNBH paradigm graphic organizer to reflect on the water cycle.

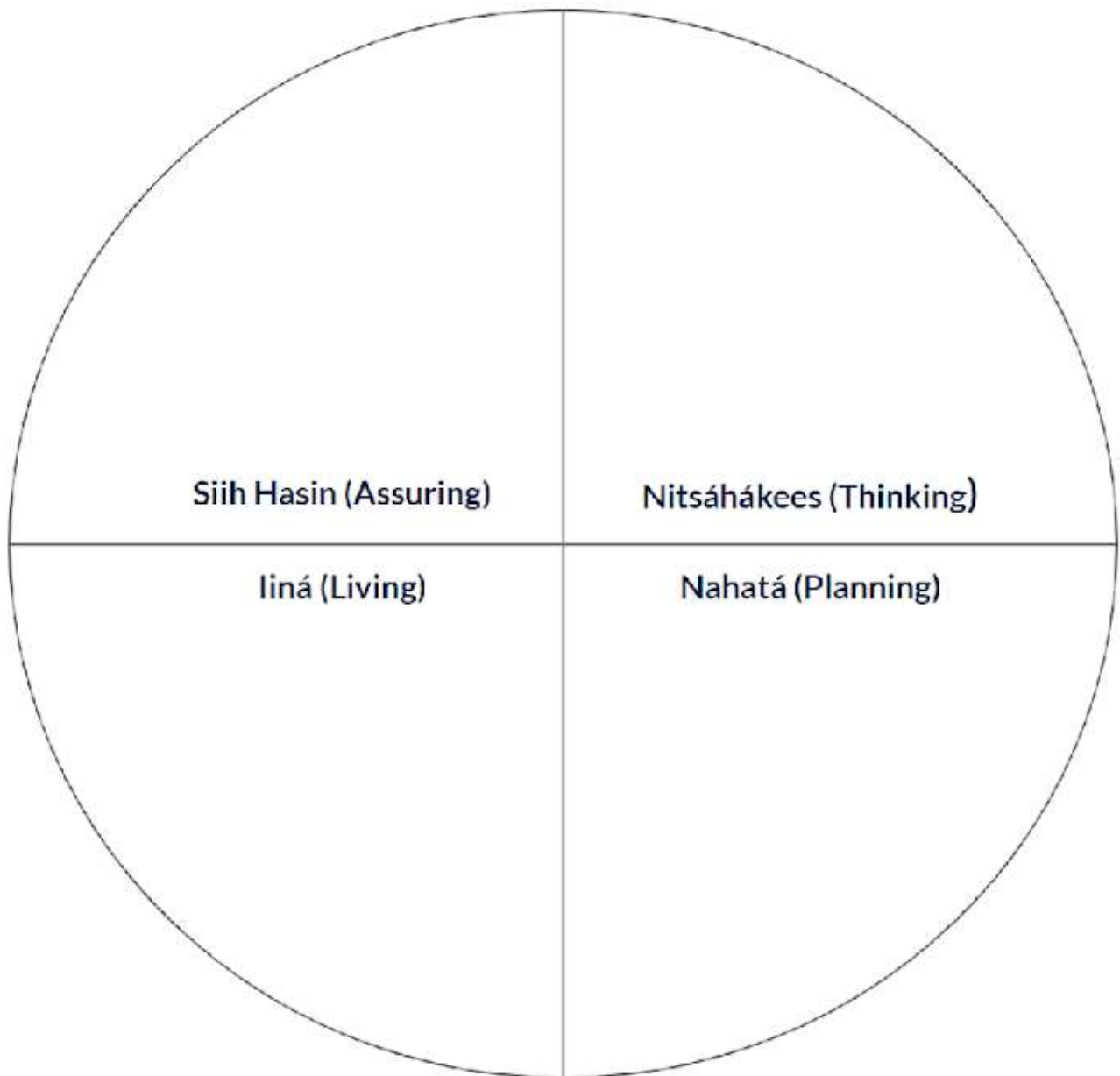
Materials: laptop, Google slides, paper, colored pencils, clay, recycle materials, pencils, scissors, and glue

Name: _____

Date: _____

Class Period: _____

Post-Assessment- Water Cycle



Directions: Using the SNBH paradigm graphic organizer, answer the following questions.

Thinking: Identify a water issue we encounter on the Navajo Nation.

Planning: Explain why these issues are occurring.

Living: How do you play a role in the water cycle?

Assuring: Design a plan on how you can improve or maintain a healthy water cycle.

Week 2:

Carbon Cycle Activity

Lesson Objective: I can use the SNBH paradigm to guide the flow of the carbon cycle using the appropriate science terms.

Goals: Student will describe/ demonstrate the movement of the element carbon through the carbon cycle.

Diné character building: I will apply and practice the Diné way of life through planning.

Key Vocabulary: atmosphere, biosphere, geosphere, carbon, photosynthesis, respiration, fossil fuels, decomposition and green house gases

Anticipatory Set: Video: [The Carbon Footprint Of A Sandwich](#)-Turn and Talk

-What is carbon footprint?

-What are some consequences of increasing our carbon footprint?

Lesson Procedure:

1. Review Vocabulary

2. Introduce the Carbon Cycle using the SNBH Paradigm- Effective Lecture (15-20 min.)

Class discussion

- What is an element?

- How does carbon play a role on earth?

3. Teacher will present assignment.

Create an illustration with that included the following; plants, atmosphere, sun, water reservoir, animal, volcano, soil, car, human, house, and fossils

a. It needs to have the carbon molecule moving along with arrows.

b. Each step in the cycle must have text that describes what is happening.

c. The diagram must include terms from the SNBH paradigm.

4. Students will describe/ demonstrate the movement of the carbon cycle using the key vocabulary to label the process.

Closure: The teacher will end the lesson with the following; [Cursed by Coal: Mining the Navajo Nation](#)

Post Assessment: Students will use the SNBH paradigm graphic organizer to reflect on the Carbon Cycle.

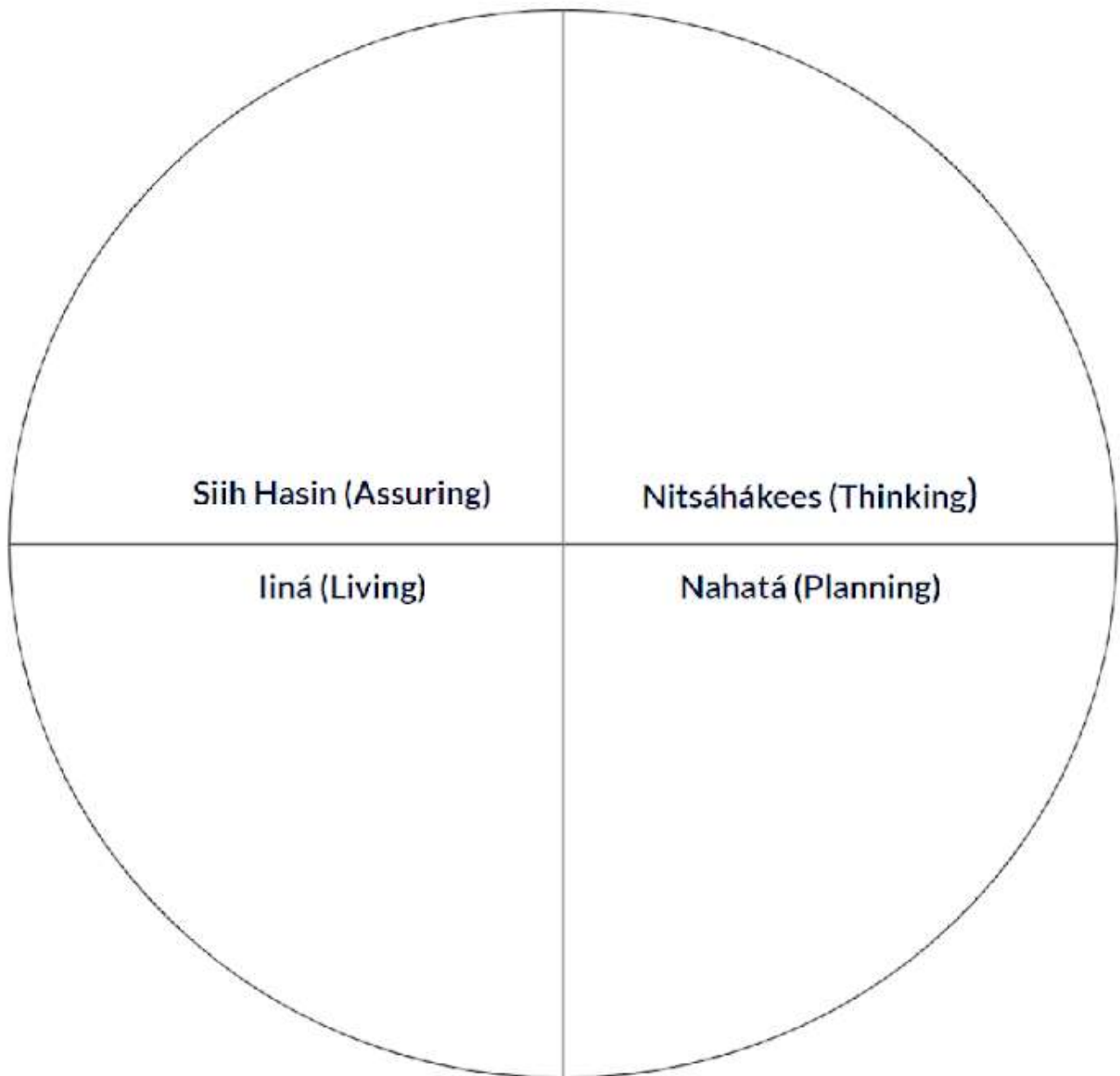
Materials: paper, colored pencils, markers, scissors, glue, and writing paper

Name: _____

Date: _____

Class Period: _____

Post-Assessment- Carbon Cycle



Directions: Using the SNBH paradigm graphic organizer, answer the following questions.

Thinking: Define the carbon cycle.

Planning: Compare the carbon cycle to the water cycle.

Living: Research how the carbon cycle affects you right now living on the Navajo Nation.

Assuring: Analyze what you learned and create plan on how you can reduce your carbon footprint.

Nitrogen Cycle Game

This lesson was based on an activity from UCAR Center for Science Education (*The Nitrogen Cycle Game* | Center for Science Education, n.d.).

Lesson Objective: I can explore the Nitrogen Cycle by modeling the movement of a nitrogen atom as it passes through the cycle.

Goals: Student will stop in different reservoirs along the way, answering questions about the process that brought them to different reservoirs.

Diné character building: I will apply and practice the Diné way of life through planning.

Key Vocabulary: fixation, nitrification, assimilation, ammonification, denitrification, nitrogen

Anticipatory Set: Video: - [Describe Nitrogen Cycle](#) Turn and Talk

-How do we use nitrogen?

Lesson Procedure:

1. Review Vocabulary

2. Introduce the Nitrogen using the SNBH Paradigm- Effective Lecture (15-20 min.)

Class discussion

- How does nitrogen play a role in our life?

3. Teacher will present assignment on Smartboard.

a. Prepare your Student Sheet or Form to document your journey.

b. Roll Google dice (or other die) to determine which center you will go to first.

c. Locate this icon on the Nitrogen Reservoir Slide and click on the hyperlink. This will take users to the first of two sequential slides that provide information that they will document in their response sheet (Form or other).

d. Proceed to the next slide and click on the nitrogen reservoir that corresponds with the number you rolled and complete the instructions on the slide.

- It is important to record the process that brings you to the different reservoirs.

e. Click the "where to go" button to transport you to the next slide.

f. Roll the dice again and click the button that corresponds with the number you rolled.

4. Review the worksheet where students document their nitrogen journey.

5. Proceed to play. After at least five- ten rounds, pull the class together to review their journey.

6. Have students share their journey.

Closure: The teacher will introduce the post assessment.

Post Assessment: Students will use the SNBH paradigm graphic organizer to reflect on the Nitrogen Cycle.

Materials Required:

[Google Slides: Nitrogen Cycle Game](#)

[Google Forms: The Nitrogen Cycle Game student response form](#)

Access to internet

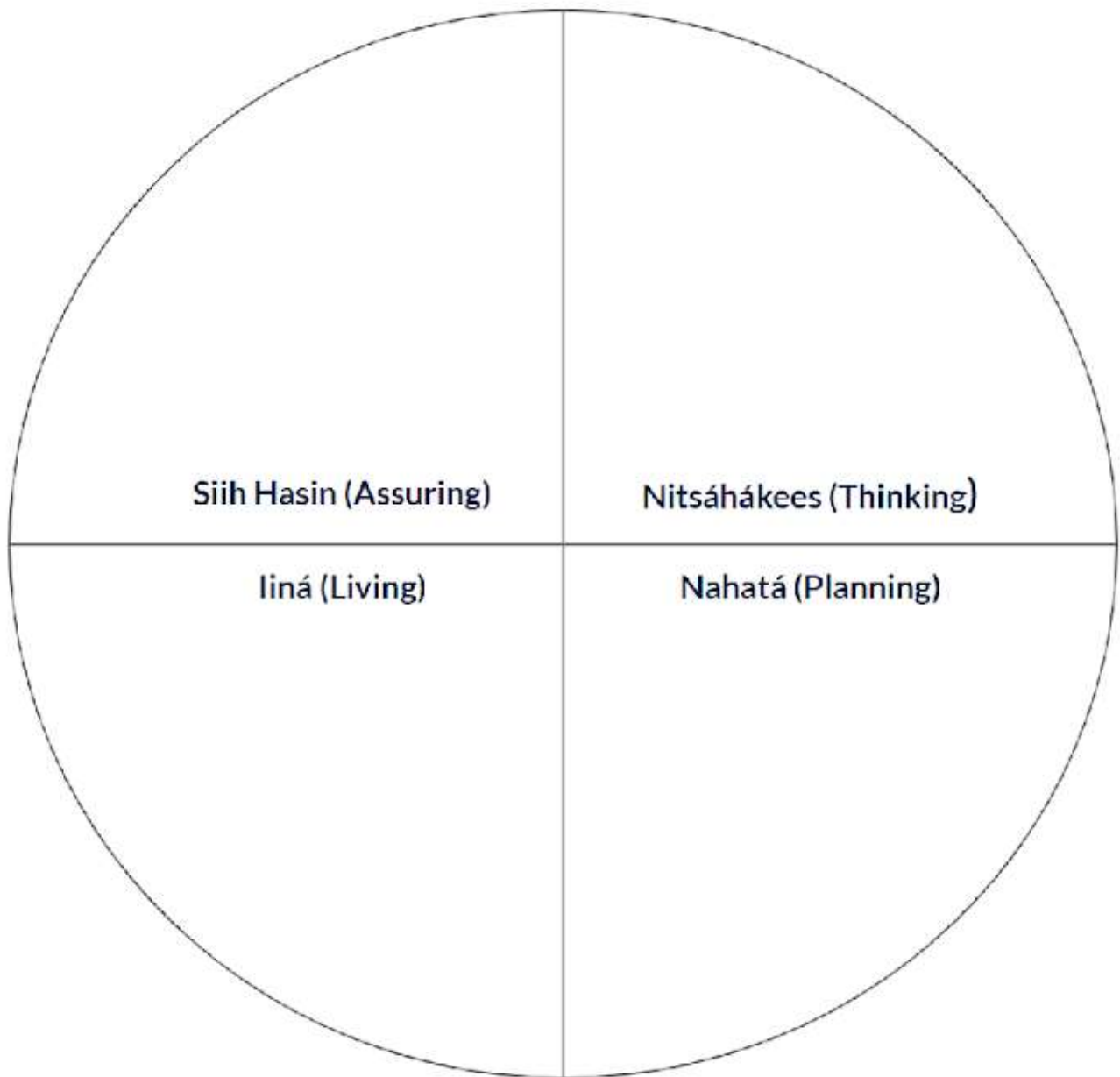
Computer, tablet, or other device

Name: _____

Date: _____

Class Period: _____

Post-Assessment- Carbon Cycle



Directions: Using the SNBH paradigm graphic organizer, answer the following questions.

Thinking: Describe nitrogen to you in your own words.

Planning: Explain some of the processes that help move nitrogen.

Living: What are some ways that human can make an impact on the nitrogen cycle.

Assuring: Reflect on your learning, why is the nitrogen cycle important

Student Assessment Plan

The students will be graded through formal and informal assessments.

Informal assessments will include responses from in-class discussions, observations, and exit tickets.

Formal assessments will include the students' response on their post-test worksheet. This will be graded based on how well the students explained each cycle through the SNBH paradigm.

Water Cycle Activity Student Friendly Rubric

	1- Needs Improvement	2- Meets Standard	3- Exceed Standard
Concept Understanding	The students demonstrated little understanding of how a water molecule can move through the water cycle. Students did not include SNBH paradigm.	The students demonstrated a good understanding of how a water molecule can move through the water cycle. Students included the SNBH paradigm.	The students demonstrated a full understanding of how a water molecule can move through the water cycle. Students included the role of the sun and gravity as well as the SNBH paradigm.
Proper Use of Terminology	The students properly used two or fewer key terms associated with the water cycle	The students properly used most the key terms associated with the water cycle	The students properly used all the key terms associated with the water cycle
Presentation Skills	The students poorly communicated the concepts in the water cycle in a manner that was difficult to understand or follow.	The students adequately communicated the concepts in the water cycle in a decent manner.	The students fully communicated the concepts in the water cycle in a clear manner.
Neatness and Legibility	One of the following is true: The project is neat. All writing is legible. The sequence is easily	Three of the following are true: The project is neat. All writing is legible. The sequence is easily	All of the following are true: The project is neat. All writing is legible. The sequence is

	followed. The project is colorful.	followed. The project is colorful.	easily followed. The project is colorful.
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Alignment with Standards

7th Grade

Arizona State Science Standards:

Core Ideas for Knowing Science: Earth and Space Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate

Core Ideas for Using Science

U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

Standard

7.E1U1.5 Construct a model that shows the cycling of matter and flow of energy in the atmosphere, hydrosphere, and geosphere.

8th Grade

Arizona State Science Standards:

Core Ideas for Knowing Science: Physical Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

Core Ideas for Using Science

U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.

Standard

8.E1U3.8 Construct and support an argument about how human consumption of limited resources impacts the biosphere.

Grades 6-8 English Language Proficiency Standards

AZ ELA Standard Alignment

Standards

- Speaking and Listening
 - 7.SL.2 Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, and orally) and explain how the ideas clarify a topic, text, or issue under study
- Reading Informational
 - 8.RI.3 Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).

Diné Content Standards

Standards

- Character Building
 - Concept 2- Nahat'á-I will apply and practice the Diné way of life through planning.
 - PO 1. I will practice my cultural teaching of earth and sky.
- Diné History
 - Concept 2- I will make connections between my culture, sacred sites and historical events.
 - PO 2. I will present a teaching based on Diné Philosophy

Resources

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<https://education.nationalgeographic.org/resource/earths-fresh-water/>
- Fort Defiance, Arizona – Watching the Navajo – Legends of America.* (n.d.).
<https://www.legendsofamerica.com/az-fortdefiance/>
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<https://latinarepublic.com/2020/09/30/generation-hb2281-how-the-banning-of-ethnic-studies-led-to-a-national-uprising/>
- <https://resourcebank.ca/authoring/1499-frayer-model/view>. (2018, October 29). Resource Bank.
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- Intro to biogeochemical cycles (article).* (n.d.). Khan Academy.
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- Murphy, D. (2016). A literature review: The effect of implementing technology in a high school mathematics classroom. *International Journal of Research in Education and Science (IJRES)*, 295–299.
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https://thebusinessprofessor.com/en_US/business-governance/scorched-earth-policy-definition
- Standing Rock Sioux and Dakota Access Pipeline | Teacher Resource.* (n.d.).
<https://americanindian.si.edu/nk360/plains-treaties/dapl>
- The Nitrogen Cycle Game | Center for Science Education.* (n.d.). UCAR.
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- University of North Carolina at Chapel Hill. (2022). Effective Lecturing. *For Your Consideration*, 2.

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<https://data.census.gov/cedsci/table?tid=ACSST5Y2020.S1101>

U.S. Census Bureau. (n.d.-b). *Explore Census Data*.
<https://data.census.gov/cedsci/table?tid=ACSST5Y2020.S1101>