Wildlife, Plants, and Habitats of the Southwest

Yiiyah! The Yellow Monster on Indigenous Land

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Context

I reside and teach in Kayenta, Arizona. I have lived there most of my life. I teach fifth-grade students who are predominantly Navajo. About 98% of the students who attend the Kayenta Middle School are Navajo, and others are either a mix of African American, other Indigenous tribes, and White. Most Kayenta Unified School District students are Native Americans, about 90% Navajo. Some White students attend school within the district. Some of the students reside in remote rural areas surrounding the town of Kayenta. The surrounding areas like Narrow Canyon, El Capitan, and the Arizona portion of Oljato, which is about twenty miles north of Kayenta, then Chilchinbeto, and Rough Rock, which are about fifteen to forty miles southeast of Kayenta, and finally, Shonto and Black Mesa, which are forty miles southeast of Kayenta. These students travel long distances on buses to school and return home. These long rides are stressful, especially for younger students. They rise before the sun and return home after the sun goes down, especially during the winter months when the days are shorter.

The Kayenta Unified School District (KUSD) is known for graduating Gates Scholars and students in sports leagues like volleyball, football, basketball, and cross-country. The teams perform well, and many travels to the state playoffs in Phoenix. The pee-wee sports program is another factor why many remote communities prefer their child to attend the KUSD schools. The pee-wee program is a third through fifth-grade activity conducted after school for an hour each day. Many of the out-of-town students enjoy the pee-wee games and tournaments. A familiar quote mentioned during the sports games and other school events is, “Once a Mustang, always a Mustang.” Meaning students who have gone through the KUSD school system will always be a Mustang. These sports competitions add to the enjoyment of the community. Parents, families, and fans travel from outlying areas to watch their children play.

The community of Kayenta has about 5,643 citizens. Kayenta is the 90th most populated city in Arizona out of 447 cities. (Arizona-demographics.com, 2022). The largest Kayenta racial/ethnic groups are American Indian/Navajo (93.9%), followed by White (3.6%) and Islander (1.0%). (Arizona-demographics.com, 2022). In 2020, the median household income of Kayenta households was $36,827, and 36.6% of families in the area were living below the poverty. (Arizona-demographics.com, 2022). Although most families struggle to make ends meet, they find a way to make an income. The tourism industry in Kayenta provides income for families during the Wednesdays Flea Market. The Market is known across the reservation, and vendors from Pueblo Laguna, Cortez, and Farmington come to sell their products. Various kinds of wares and products are sold to provide income to families who do not have a steady income. Products like jewelry, alfalfa hay, clothes, blankets, tools, and even food vendors sell snow cones, blue cornmeal, and mutton stew with fry bread.

The Peabody and Kayenta Coal Mines closed in 2019, and the Uranium mines closed in the late 1980s (Pasternak, 2010). Although Kayenta provides these families with an income, it also has a history of coal and uranium mining. These mines were temporary solutions to assisting families with low incomes to get good-paying jobs, but the mines damaged the health of many mine workers. The exposure affected fathers, uncles, brothers, and extended families. The sad history of Navajo men working in the uranium mines has affected many families, and the effects are still prevalent today.

Rationale

Analyzing and researching the uranium problem on the Navajo Reservation is a topic of concern and is an issue our students need to understand and know about. Students need to know what our leaders agreed to by letting uranium corporations and the US government come onto the reservation to extract uranium ore and other natural resources.

Although mining uranium stopped during the 1980s (Pasternak, 2010), the issue is still prevalent today because many miners are still getting sick and dying from the exposure downwind and from having worked in the mines, unprotected from the exposure to hazardous materials. Our children are our future generation, and how will they survive with the uranium problem still lingering in their backyard? What will they be doing to make Diné Bikayah – the Navajo Reservation, a better place to live? The topic of uranium and Navajo history of what happened to the Diné people is a historical event. Our history, culture, and language are what our students know to sustain us. Educators are caught up in teaching the standards and scripted curriculums and do not focus on students' culture, language, and local history. They lack knowledge and are unaware of their local surroundings and local history.

The students who live in the remote areas of Kayenta have seen abandoned caves and open-pit areas while hiking, herding sheep, and riding the horse trails. Students and families know about some of these sites and tell their children to avoid these unsafe and toxic places, but many of them do not know to watch out for these toxic places. Many of the students live within multi-generation families. They have uncles, aunts, and maternal or paternal grandparents living with them. These family members care for them because some student parents reside and work in the cities. Most families are oblivious to the uranium problem on the Navajo reservation that affected the earlier generations from the 1930s through the 1980s. Young generations need to know about what happened to their people and the dangers of what will happen when companies come in to extract ores from the land.

The uranium issue has been a problem since Diné families showed up at the clinics and hospitals on the Navajo Reservation during the early thirties through the late eighties. Many Navajo families began to show cancer symptoms and died from exposure to working in the uranium mines or residing near the mined areas. Many men who worked in the mines did not know how dangerous inhaling uranium affected their bodies (Morales 2017, Pasternak, 2010).. Ingestion or inhaling a high uranium concentration of a toxic chemical can cause severe health problems like cancer of the bone, liver, lungs, and kidney damage) (Morales, 2017, Pasternak, 2010). Students need to know what toxic chemicals can do to harm the body, mainly uranium, and to know the history and personal stories of the Navajo men who mined the mines and the families who lived near the mined areas.

Students need to know how the government and private companies took advantage of uranium's natural resources from Navajo families' land. Obtaining the uranium for the war effort was the goal of the government and mining companies and, of course, money. The families and fathers who were uneducated or trained in handling the toxic minerals in the mines and open-pit areas were unimportant. They knew the dangers of uranium exposure, but the government and private companies did not even step in to protect and inform the Navajo miners. Students need to know

what happened to these families because most of them have passed on, and the next generation needs to heal from the loss and damage of a broken generation. To be educated in local history so that the history of the damages to the Diné people will not repeat the cycle. Students can be informed and aware of what the US government and private companies can do when they come onto the Navajo reservation for their purpose.

Mining uranium affects all aspects of living in harmony within the Diné culture. It damages lives, and there is no Hózhó when family members get sick, get cancer, and die from uranium exposure. How can students who have lost family members sustain and retain K'e and Hózhó? As a teacher, I need to find solutions to prepare students to be informed and aware of social injustice and environmental injustice of what has happened to our people and our land.

Content Objectives

The content of my curriculum will be about the historical damage of uranium mining to Native Americans living and working on their reservations. What uranium is and what happens when the ore is left exposed on land, seeping into surface water and water tables, floating in the air, and what it does to the human body. Many workers did not wear protective safety gear or were not educated or trained about the dangers of uranium exposure and no ventilation inside the mine. Indigenous people were considered second-class citizens to the US government and uranium companies because their goal was to extract as much uranium as possible so the workers could support the war effort.

What is Uranium?

Uranium is a heavy metal that has been mined and used for about sixty years. Uranium was discovered in 1789 by Martin Klaproth, a German chemist, in the mineral called pitchblende. (World Nuclear Association, 2016-2022). The common ore is found in the Earth's crust, and land formations. It can also be found in water or soil, as the rocks containing ore erode, known as "weathering," allowing the uranium to then get into the water or soil (New Mexico Bureau of Geology and Mineral Resources a, 2022). Like other elements, uranium occurs in several slightly differing forms known as 'isotopes.' The isotopes differ in the nucleus's number of uncharged particles (neutrons). Natural uranium, as found in the Earth's crust, is a mixture mainly of two isotopes: uranium-238 (U-238), accounting for 99.3%, and uranium-235 (U-235), about 0.7%. The isotope U-235 is important because it can readily be split under certain conditions, yielding much energy. It is therefore said to be 'fissile,' and we use the expression 'nuclear fission. Uranium has a melting point of 1132ºC, and the chemical symbol is U. (World Nuclear Association, 2016-2022).

These isotopes decay, with U-238 decaying very slowly, and U-235 decaying faster. However, the energy from the U-235 atom contains 92 protons and 143 neutrons, which equals 235 (therefore the name—U-235). The energy from the atom captures a moving neutron; it splits in two, and energy is released. When this happens, a few additional neutrons bounce off. If enough of them bounce off and contact causes the nuclei of other U-235, it can split and release more neutrons. A fission "'chain reaction'" occurs, and when it happens over and over, "many millions of times, large amounts of heat are produced from a small amount of uranium. (World

Nuclear Association, 2016-2022), U-235 is a preferred uranium because it is lightweight and more unstable than the other heavier minerals (World Nuclear Association, 2016-2022).

Uranium on the Land

There are three ways to extract uranium from the land: open pit, underground, and in-situ leach (ISL).

Open Pit Mining

Open-pit mining is known as strip mining. It removes unwanted surface soil and rock to get to the uranium ore below. The removed rocks and soil are usually moved near the pit and backfilled after the uranium ore removal. This type of mining is proper when the ore is near the surface because some of the ore is visible. Once the ore is exposed, the pit is cut in layers of steps to make removing the uranium easier. For example, the Jackpile Mine on the Laguna Pueblo reservation was one the world's largest open pit uranium mines. (New Mexico Bureau of Geology and Mineral Resources b, 2022). Depending on the size of the pit, roads are constructed for large trucks to haul out the ore. The positive benefits of open pit mining are that the cost is not as extensive, the open-air ventilation reduces toxicity to the mine workers, and stricter environmental safety and health guidelines. The reclamation of the land, dust control, and radon are monitored. The negative impacts of open pit mining are that it leaves a considerable carbon footprint meaning an excessive waste of unused contaminated rocks, the costly reclamation of groundwater exposure, and the compromise of mine workers' health due to dust from contaminated rocks and radon gas.

Underground Mining

Underground mining is used to extract uranium that contains a higher concentration that is deeper to get than open pit mine. The ore is drilled and then blasted into shattered pieces of rocks and ore. Then the rubble of ore is transported to the surface and shipped to a mill plant. The plus side of underground mining is that it creates a smaller carbon footprint, wastes fewer rocks, and causes Less radiation and health issues because dust and radon gas settle in the aftermath of the explosion. Dust, radon, and other fumes threatened miners' health because of area exposure. The harmful effects are the expensive cost, the impact of nearby underground aquifers damaged, then reclamation becomes expensive.

Milling

Milling is a process used by surface and underground mining to pulverize rocks into minute fragments. The fragmented rock and uranium are processed with water to create a slurry. The slurry is mixed with sulfuric acid or an alkaline solution to release uranium. Approximately 95-98% of the ore is extracted from the slurry. This acid or alkaline solution precipitates uranium oxide or yellow cake. (New Mexico Bureau of Geology and Mineral Resource). The yellow cake is not 100% pure and is sent to another mill to purify it more. The unused slurry is shoved into an artificial dam and exposed to the surface, with toxins emitted into the environment

In-Suti Leach (ISL) Mining

In-Suti Leach Mining is a choice method for extracting uranium because it is cheaper to get the ore out of the ground. It is considered more environmentally safe and friendly than pit or underground mining. The ISR process involves pumping water from the formation and adding oxidants such as gaseous oxygen. For other extractions, a carbonate phase, such as sodium bicarbonate (baking soda), is added to the solution to make it easier for uranium to seep into the solution. The pH of the solution oxidizes the uranium into porous sandstones and makes it easier to go into the solution. As the solution moves through, the rock dissolves the uranium into the ground wells at a specified distance from the injected wells pump, then uranium and enriched waters move to the surface (New Mexico Bureau of Geology and Mineral Resource). When pumping fluid into the wells, excessive water is pumped into the hole. The excess water creates a "cone of depression," preventing or minimizing off-site migration of uranium and mineral-enriched water (New Mexico Bureau of Geology and Mineral Resource). The water is treated and filtered to remove the uranium and then refreshed with oxidants and carbonates. The process is repeated, sending the water back into the hole again. After the uranium is depleted, the requirement is to restore the water to prescribed standards to ensure that potable water sources are not impacted.

The excellent report about ISR is that the carbon footprint is not extensively impacted. There is little wasted rock, and it is not expensive to initiate the process, unlike traditional mining and milling. There is less radiation exposure for the laborers, and it does not require tremendous amounts of human resources but a small, highly trained workforce. The lousy report about ISR uses local aquifers and possible local contamination because water is pumped and monitored during and after use. The possibility of wastewater disposal and residents' fears of unsafe water.

Uranium in Air

Uranium mining adds another risk because of elevated concentrations of radionuclides in the air. The radionuclides exposure during the mining process can be through inhalation, ingestion, or absorption through the opening of the body cavity. Wound absorption occurs through the oral cavity of the nasal, mouth, and open cuts.

Radiation typically encountered in uranium mining or processing facility operations includes alpha (α), beta (β), and gamma (γ) radiation. The three types of ionizing radiation—are energy in the form of particles or waves that has sufficient force to remove electrons from atoms. Alpha particles consist of two neutrons and two protons, travel only a few centimeters in air, and can cause a high density of ionizations along their path. When radionuclides decay by alpha emission (e.g., polonium-218, polonium-214) are inhaled, they can impart a significant dose to the pulmonary epithelium. (Uranium Mining in Virginia) Although alpha particles travel a short distance, they give a more significant effective dose than the other two. Alpha particles are environmental carcinogens because they are potent when they enter the DNA strands. These particles break strands, making it more difficult for the body to repair them.

Beta particles have lighter and faster electrons when compared to alpha particles and beta particles. Beta particles have more penetrating power than alpha particles. Beta particles can

travel farther than alpha particles, over fifty centimeters in the air, and can do more damage to the external layer of the skin than to internal parts of the body. When the uranium ore begins to decay, radiation particles or electromagnetic radiation separate and can produce various doses of alpha, beta, and gamma rays. In most exposure scenarios related to uranium and processing, gamma rays present a more significant external than internal radiation hazard. The energy deposited by alpha, beta, and gamma radiation can damage or kills cells. The impact of radiation depends on the duration of radiation. (Uranium Mining in Virginia) Most unused uranium and its decay products are left in the tailings and waste piles. The radionuclides become leached materials and airborne dust, which pose a health hazard when inhaled or ingested. The radiation exposure depends on the area where miners work. For example, miners working underground have much greater exposure to radon and radon decay than workers in open-pit mines. The radioactivity varies on short-lived particles and the longer-lived decay products. The work in processing the uranium is also a factor, like input and moving yellow cake into drums. The dosage of the yellow cake increases the radiation when the drums have been sitting and stored for months. The actual processing of uranium poses a more significant exposure risk. The separation of uranium creates alpha and gamma radiation, airborne radioactive materials which are inhaled and ingested and eventually cause lung cancer.

Uranium in the water

Uranium in water can occur by contaminated water or the leaching of radioactive materials into the surface and groundwater. In most mines, water is used to settle the dust; sometimes, underground water is near the uranium vein or core, and an active mine will contaminate the surrounding. Tailings of unused radioactive products run water into nearby water pools and can seep into the water table.

Water at and near the mines, underground or open pits, must be removed and treated. Contaminated water is not recycled and must be treated to meet the Environmental Protection Agency standards. The treatment depends on uranium content, the chemicals used, and other ore contaminants. Not only water, but contaminated solids like soil, vegetation, heavy metals, and other contaminated products need to be removed or treated. The type of treatment depends on how the company conducts the cleansing or disposal process, like the type of ore treated and the type of chemical used. In the end, the company must ensure the treated water and area meet the environmental guidelines before clearing the area (EPA b, 2022).

Another process used was the dewatering effect. This procedure is used so the mining of uranium can continue. The technique prevents groundwater from entering the area, and the water is pumped out to the surface or into a local water table. Moving water to other sites can affect surface water because it is filtered within its natural environment from the rock layers, the depth, the pathways, the time water is in the aquifer, and other elements are involved. Mining activities can alter these variables and change the water quality. For example, it was dewatering a uranium mine near Gallup, New Mexico, and increased dissolved gross alpha, gross beta, uranium, and radium activities in Puerco River from 1967 until 1986. The mine discharges into the river were treated with flocculant and barium chloride to reduce total suspended solids and co-precipitate radium. It means diluting the concentrated discharges using an ion exchange treatment. This process met the water quality standards before releasing water off the site. (ATSDR, 2015)

The Church Rock Spill

Uranium was in demand since the discovery of ore on Native lands. Native Americans are the underprivileged populations targeted for cheap labor when it comes to mass-producing products. Native Americans were usually not on the front page when minor events happen to a cluster of people, but news travels when incidences affect most Native populations. The mine produced more than two million pounds of uranium oxide. The ore excavation from the mine within the Church Rock area began in 1968.

For example, the Church Rock closure has not been thoroughly completed with the cleanup. The tailing piles within the area had passively seeped into homes and family lives. The exposed uranium tailings, dust, and contaminated water caused sickness, and many former miners and their families were getting cancer and dying from the exposure. Then more waste from the mine caused more damage. In 1977, large cracks were discovered in the dam and were not reported to the authorities. In 1978, the dam at the Church Rock Mill collapsed, releasing 1,100 tons of radioactive detritus and 95 million gallons of wastewater into the Puerco River. Two aquifers were affected, and contaminants flowed downstream at 130 km. (New Mexico Bureau of Geology and Mineral Resource.) Numerous samples of water, soil, air, and sheep were tested, and a significant increase in radioactivity was elevated. The river had been the community's source of drinking water for livestock, recreation, and cultural purposes.

Officials warned the communities not to use the contaminated water. The United Nuclear Corporation eventually dug new drinking wells and removed 3,500 tons of sediment from the Puerco River, but this amounted to only 1% of the estimated total spill material. (New Mexico Bureau of Geology and Mineral Resource.) The slow progression of the cleanup caused more damage to the local groundwater. The Navajo Nation's Tribal Council's Emergency Services Coordinating Committee requested to declare the spill a federal disaster. In the aftermath of the spill, the operation of the mine continued until 1982 it was abandoned. Eventually, Church Rock would be placed on the Environmental Protection Agency's National Priorities List in 1983. (Nguyen 2019)

Presently, the health conditions of the Church Rock community were fully assessed because a complete diagnosis of the individual was lengthy and costly. When assessing or diagnosing a, numerous individual data needed to be collected like the specific location of water consumption, homesite, whether sheep and local cornfield plants (corn, melons, pumpkins, and peaches) were consumed, exposure to uranium employment, interviews of the individual's daily walkabouts and recreation. Many matrixes will vary for everyone who was exposed and is continually exposed. The government and corporation's responses to the Church Rock spill were unsatisfactory, tedious, and slow in helping the community. The slow process cost the lives and health of the Navajos living in the area. Other factors were the lack of media coverage, overall awareness of the incident, and of course, the Navajo people are a small minority group who are underprivileged and overlooked by the majority.

For example, the nuclear incident at Three Mile Island captured national and global attention. The leaked radioactive material and mass evacuation of thousands of residents in Pennsylvania

was publicized extensively compared to the Church Rock spill on the Navajo Reservation. Church Rock spill was more damaging, releasing intense toxic radioiodine into the environment, than Three Mile Island. The Navajo residing in Church Rock did not receive the same degree of public assistance as did the communities affected by Three Mile Island. (Nguyen 2019)
As global demands for nuclear power increase, uranium ore mines will reopen. When this agreement ever happens, preventative measures must be in place to protect the communities near the mine sites. All mine activities like protecting workers, construction, and closure must follow strict protocols to protect all life. The before, during, and after of regulation, education, and comprehensive plan on dealing with nuclear accidents and mine spills. (Nguyen 2019)

Uranium in the Body

Uranium can enter the body through external and internal pathways—the mouth, nose, ears, and skin. The human body is a fantastic system in which toxins can enter and exit the body. Uranium, radon, radium, and cadmium enter the body as dust particles, liquid in water, and gas.

Human intake uranium into their bodies from the food eaten, water intake and air inhaled and exhaled. When uranium dust is inhaled, some of it is exhaled, and the intake remains in the body when swallowed. Some enter the bloodstream, and the rest remain in the body and can slowly build up over a lifetime. Only about 0.76—5% of the uranium a person breathes will enter the bloodstream through the respiratory tract (nose, mouth, throat, and lungs). Some inhaled uranium can stay in the lungs for a long time. About 0.1—6% of the uranium a person ingests will get into the bloodstream through the gastrointestinal tract (mouth, stomach, and intestines). Uranium compounds that dissolve in water enter the bloodstream more quickly than uranium compounds that are poorly soluble in water. (ATSDR, 2015)

When uranium is absorbed, circulated, and deposited throughout the body, the concentrations are found in the bones, liver, and kidneys. About seventy percent of the uranium in the body is situated in the bones. It can remain in the bones for a long time. However, the uranium's main target is the kidneys. Kidney damage findings in humans and animals after inhaling or ingesting uranium were consistently found in medical diagnoses. Ingesting water-soluble uranium will affect kidney functions. (ATSDR, 2015)

People get exposed to uranium by food, water, jobs, and the environment they reside. Humans eat food and drink water every day, and these consumptions are some of the primary sources of uranium exposure. Root crops such as potatoes, parsnips, turnips, and sweet potatoes contribute the highest amount of uranium to the diet. The amount of uranium in foods is directly related to the amount in the soil. (ATSDR, 2015)

Workers who work with uranium are exposed and are at risk of ingesting and inhaling uranium particles. The uranium mines, mills, and places that process uranium or manufacture products that contain uranium are more likely exposed to the toxic mineral. People who reside near the uranium sites (mine, processing, and manufacturing facilities) are more likely exposed to uranium than populations away from the concentration of uranium.

Humans and animals need to be cautious of how and where high levels of toxins are within their surroundings. Uranium is found in many parts of the world, and the human body can only intake sure of toxic ore. It is found in water, food, soil, plants, and the air.

Pathways of Uranium

The pathways of uranium have been studied in the Diné Nation among Navajo families and their herds of sheep. It is widely known that there are numerous abandoned uranium mines on the Navajo reservation and sheep herders and sheep roam the open range. Many open uranium mines have existed since 1950 to today. Many herders were oblivious to open mine pits and unaware of the dangers of uranium tailings.

On the Navajo Reservation, the study of analyzing sheep body parts was conducted in the area of Cameron, Arizona, located in the northwest state of Arizona. Many residents are predominantly Navajo natives who have resided there for generations since the return of the Long Walk in 1860. Navajo people relied on sheep as their main staple of food consumption since the arrival of the Spaniards during the early 1500s—sheep sustained families for food, income, clothing, and ceremonial purposes.

The research was conducted around Cameron during social gatherings like holiday events, graduation receptions, weddings, and ceremonial events like Ndaa, Awee' deezdloh, kinaaldah, doo Ye'ii becheii, and additional traditional events. The sheep is an essential source of food for many of the events. Surveys were conducted at social gatherings in Cameron, Arizona, between June and October 2017. (Ingram, 2019) The reason for the research was that the Cameron communities concerned residents about the area's toxicity and elevated levels of uranium. The water, vegetation, soil, air, and food were the community's inquiry, but the focus was on the sheep.

After many red tape approvals from the chapter, the Navajo Tribe, the Northern Arizona University research team, Navajo Western Agency, Tuba City Health Board, the Diné Hataalii Association, and other entities, the research was conducted (Ingram, 2019). Of the 72 participants who completed the survey, most were 40 years and older (72%), female (60%), identified as Navajo (96%), and were from the Cameron Chapter (57%). The number of participants not living in the Cameron Chapter (43%) is identified as people who grew up in Cameron as children but have moved away and lived elsewhere as adults. About 25% of participants own sheep. (Jani Ingram 2019) Several questions were asked about whether the importance of sheep during ceremonies would change or not. The percentages among the female and male participants varied, and the age difference among elders 70 years and older to younger participants <55. An additional question asked was about the preparation of sheep dishes of different organs and tissue parts, and the preferred consumption of meat and organ parts was collected as data for the survey (Ingram, 2019).

In the end, the study concluded that consuming contaminated mutton is not known to cause cancer, but it is to have the community be informed and aware of uranium exposure within their surrounding environment. More studies in the future will reveal what is safe to eat when open range of livestock, like sheep as part of the Navajo tradition and culture. As cultural and

traditional practices continue, sheep will be part of ceremonial meals, special events, and family gatherings. The area of Cameron was an ideal place to conduct and gather data for uranium in sheep, but other areas on the Navajo reservation have abandoned uranium mines that required intense uranium exposure investigation (Ingram, 2010, EPA b, 2022).

Environmental Injustice and Indigenous Environmental Injustice

The uranium industry on has accomplished their goal in obtaining uranium ore but did not analyze what had happened after the closure of their mines. An injustice to the Indigenous people around the world has impact negatively with their lives and their lands. The operations of the mines have damaged and killed many unprotected mine workers in unsafe and crude conditions. Government and private companies took advantage of the ore mined on Indigenous lands. Native people were obliviated of the working conditions of the mine. They trusted the supervisors and government companies in the safety protocols. These entities knowingly knew of the danger of mining ore without protection but making a profit was their goal, even taking shortcuts in not following safety guidelines. The term environmental justice is about fairness in environmental decision making, and making sure that low-income, minority, or Native American peoples do not bear a disproportionate burden from that decision-making (Jarratt-Snider and Nielsen, 2020). Indigenous environmental justice means understanding the ”unique factors” in environmental justice issues relative to Indigenous Peoples (Jarratt-Snider and Nielsen, 2020). Those factors are “sovereignty, connection to homelands, and continuing impacts of colonization” (Jarratt-Snider and Nielsen, 2020). The examples of uranium mining on Indigenous lands in this unit show the disproportionate burden put upon Indigenous Peoples as a result of uranium mining on their lands. One important aspect of understanding Indigenous environmental injustice is to tell the world what happened to the original native people and their land with the mining industry. An environmental injustice, social and criminal justice are damages that Indigenous communities had to survive through from the dominant society. It has been this way since the Whiteman landed on Indigenous lands. In the following subheadings below, Indigenous tribes around the world have tirelessly demands their government to assist in cleanup of toxic chemical debris their companies left behind. It has been a lengthy and slow process, but something is happening, and as Indigenous tribes cease the mining and fight to protect their people and lands, there is hope.

Uranium and the Diné People

There are hundreds of abandoned uranium mines on the Navajo Reservation, and many of them are not sealed. Uncovered mines are targets for people and animals to enter unsafe structures. Mines in the Navajo Nation were commonplace for Navajo men looking for employment. Numerous mines were in Cameron, Arizona, in the Monument Valley area known as VCA – Vanadium Corporation of America, and along the Carrizo Mountain which is located on the eastern part of the Navajo Reservation.

These mines opened in the 1940s through the 1990s. Many Navajo men searching for employment readily accepted the jobs at the mine. Workers were informed they were helping Americans with the war effort in Europe, and it was a patriotic duty to work hard and produce much uranium. Many Navajo miners worked in the mine for more than ten years without

protection. Many were not formally educated and trusted their supervisors' duties and operations. The mine workers were not informed of the dangers of mining uranium ore (Pasternak, 2010).

Many Navajo men were elated to find work near home because the mode of transportation during the peak of the demand was by wagon, horse, or foot. The men moved their families closer to the mine, so work was in their backyard. Children roamed the mine on uranium tailing mounds, threw the yellow dirt at each other and even swam in the man-made ponds near the mine area. In addition, mothers use the rocks to create a fire pit to cook their meals and rocks to hold down their makeshift tents or sheds (chaa'oh).

After the closure of the mines, the men who worked in the mine began to have cancer-related health issues. Many began to die of cancer which attacked significant organs and bones. The cancer rate among the Navajo worker increased more than at other mine sites off the reservation. Navajo officials and miners' wives began to voice their concerns to Washington. The government agencies realized they needed to do something to compensate for the damages to the land and to the Navajo men who worked in the mines (Pasternak, 2010).

These damages cannot be fixed. How will the government fix the land and return it to its original state? How can they fix broken families who lost fathers, uncles, and brothers? Covering the mined areas will temporarily solve the problem, like covering it with a band-aid. These covered areas will need to be monitored for four million years because uranium tailing takes a long time to decay. Then, the loss of family members, how can the government compensate for life, in fact, many lives? Some of the husband's wives stated that their husband's life is not a price tag and cannot put a price on a person's life. These wives want their husbands to return. The government does not have the power to help bring men back, but they can take ore out of the land at a low price for the good of the war effort. Our tribal leaders need to stand against mining on Navajo lands and to solve and fix the damages because our children and their children's children.

The price of the land and damaging people's lives are crimes of environmental injustice to all living beings' right to live and to the land known as Mother Earth.

Uranium and the Pueblo in New Mexico

Mount Taylor is in northwest New Mexico and northeast of Grants, a town below the mountain. To the Indigenous tribes, the mountain is sacred. The Navajos (Diné) called it Tzoodzil (Turquoise Mountain), Kaweshatima for the Acoma, Dewankwin Kyaba:chu Yalanne for the Zuni, Tsiipiya for the Hopi, and Tsipina for the Laguna. (Berthier-Foglar 2012)

In 2009, approximately a decade after closing the last uranium mine in the Grants area, New Mexico appropriated $150,000 to assess the safety issue of abandoned uranium mines. Of the 400 mines believed to exist, 259 have been located, and 137 have had no cleanup. Many of the mines' ranges test holes known as "dog holes," which are large enough for a miner. Many mined areas are within the uranium belt along the Mount Taylor Mountain range. Many mines were located near families' homes, where children used the flooded hole for swimming. (EPA a, 2022).

Since the early fifties, nuclear energy has been deemed a necessity for uranium mining companies to support the war effort, and many of them staked their claims along Mount Taylor. Energy needs were in demand for America to produce the resource. (Berthheir-Foglar, 2012).

One such mine is the Jackpile-Paguate Uranium Mine. It is located on the Laguna Pueblo in Cibola County, New Mexico, about forty miles northwest of Albuquerque. It operated from 1953 to 1982 and was once the world's largest open pit mine. The mine property encompassed over 7,600 acres in an area of canyons and arroyos directly east of the village of Paguate. The mine site has three open pits, numerous waste piles, and unprocessed ore stockpiles scattered throughout the area. (EPA a, 2022).

The mine closed in 1982, and reclamation of the area was conducted, allowing the surrounding population to use the land. They were allowing limited livestock grazing, storage of major mine equipment, and minor mining. Other uses were not allowed, like farming or residing in the mined areas. The reclamation was completed in 1995, and investigators found the site needed further cleanup of radioactive materials and other contaminants at the site, especially substances from the two rivers, the Rio Moquino and Rio Paguate. Contaminated fish were found, and people were within a five-mile radius of the area. About a thousand Native Americans reside near the mine site. These villages near the mine include the Laguna Pueblo villages Paguate, Laguna, Mesita, Encinal, Paraje, and Seama; and the Spanish villages of Bibo, Moquino, and Seboyeta. Paguate, the closest village to the mine site, is about a thousand feet from one of the pit sites. Other villages have been reported to have used old mine materials and rocks as building materials. (EPA a. 2022) Wastes from mining, like radioactive materials and heavy metals, have contaminated streams and reservoirs. These water bodies provide life to the area's people, plants, and animals (EPA a. 2022).

The Paguate Uranium Mine is a Super Fund Site and was on the National Priorities List in March 2012 by the United States Environment Protection Agency (EPA) (EPA b. 2022). The Agency for Toxic Substances and Disease Registry (ATSDR) evaluated the area for community exposures and recommended preventing hazardous substances from exposing the surrounding area and the community. EPA continues to survey residents, monitor for radiation, and present radon programs, and continue water and soil sampling for contaminants. EPA shares the results with entities involved and the nearby communities. EPA and ATSDR will communicate and cooperate when conducting additional environmental sampling to progress through the phases of the Superfund process. (EPA, 2022). The leaders of the tribe and community tracks the progress to ensure the community's safety.

Uranium and the Aboriginal Peoples of Australia

There are about 500 different Aboriginal peoples in Australia, each with its language and territory and usually comprised of many separate clans. Archaeologists believe that the Aboriginal peoples first came to the Australian continent around 45,00 years ago. (Survival 2020)

Even since England/Britain invaded the continent, the Aboriginals have had their land stolen and destroyed by the government and corporations interested in uranium mining, cattle ranching, and

other profitable businesses. Until 1992, when finally overturned, the legal principle of the British government and Australian law regarding Aboriginal land was that of "terra nullius," meaning that the land was empty before the British arrived, belonged to no one, and could legitimately be taken over (Survival 2020). "Terra nullis" was proclaimed by the British even though there were an estimated 750,000 Aboriginal Australians living there at the time of British colonization (Au (Aboriginal Heritage Office, 2022).
Some land was returned, but the loss of their land affected the tribe and many clans' social and physical dynamics. Since the invasion of white people, many thousand Aboriginal peoples were wiped out by diseases they were not immune to, and many others were massacred. In just over one hundred years, much of their traditional land was taken, and their numbers were reduced from more than a million to only 60,000. (Survival, 2020). Today, the Aboriginal peoples are impacted by the dominant English ideologies and ways of living.

The Aboriginal peoples live straightforward traditional lives by living off their land. They live with their land using their culture, language, ceremonies, and songs. Many of these Aboriginal peoples prefer to raise their families and continue to practice their traditions. They practice them on sacred land sites specific for their ceremonies. During the invasion of Britain, these land areas were claimed by mining companies which destroyed Aboriginal lands and inhibited their ceremonial practices. The influx of English mines brought diseases and alcohol abuse which devastated many families. Some families receive mine royalty money for the use of mining on land claimed by clans.

As mines claim lands for mining, Aboriginal families lose their homes and move into the nearby mining town, where they must adapt to English norms of living. They live in houses, and their children attend school and work jobs to pay for in-town expenses and medical provisions. The sudden change impacted many families and became stressful for them. Alcohol has become a prevalent destress factor and is easily accessible in the towns. It is commonly known that alcohol breaks down the family, culture, and traditional dynamics. Many broken families had to learn to adapt to the English life, but some were unwilling to do so, and preferred traditional living (Behrendt and Strelein, 2020)

Today, a major mining company provides compensation to Aboriginal peoples. The payment of concrete compensations like training programs, employment opportunities, health centers, educational provisions, and housing are examples of the types of payments provided. The type of compensation is part of the mining agreement that was negotiated in 1984 between the Gagudju and Denison Mining Ltd. (previous partners in Koongarra), included $256 million in royalties and a 25% equity in the project, as well as arrangements to employ Aboriginal people and provide job training and secondary and tertiary scholarships. (Wilson, 1997) There are some positive changes for the Aboriginal peoples of Australia with assistance from the dominant government and mining companies. The English government make attempts to assist the many clans throughout the country and they need to know and understand Aboriginal culture, traditions, and language to know how to help Indigenous tribe because they are dwindling in numbers.

Teaching Strategies

Timeline

A timeline concept is a graphic representation of chronological events in time. I will include detailed information with visuals and content information when teaching the uranium timeline. A timeline is a text alternative. Students are more engaged and interactive in learning the sequence of historical events. A historical timeline helps students make connections with historical events and think about how they understand continuity and change in time. Students can put their information onto the timeline to see where they fit in the historical sequence. The uranium timeline of the Diné people will contain photographs of the place people, detailed informational passages, and narrative stories connecting to the artifacts. The timeline is an interactive chart because students will add and move information, they think are essential to the chart.

Timelines can be vertical, horizontal, or in a circle. The timelines teach students how to use the strategy to understand the historical events of the time and how history changes in years, decades, and centuries. The timeline our classroom will create is circular because, in the Diné culture, the circle is a way of life from the beginning to the end of life, east to south, west to the north, and back to the west. I know students will connect to the Circle of Life concept with the circular timeline. Additional literature is used to supplement the timeline regarding content, topics, and dates. Some of the literature will show visuals of vertical and horizontal timelines.

Classroom Activity

Personal Timeline

The teacher conducts a guided teaching strategy with students and explains the components of a timeline and how a timeline is a helpful graphic organizer activity. After explaining the class timeline, students can begin analyzing the critical dates during their lives, like birthdays, vacations, and promotions, when creating their timeline. My students are in fifth grade, and their timelines will not be as extensive as the ones on uranium classes. In addition to their events, students will add major global, national, state, and local events that have impacted their lives. It will begin to look like wedges of a pie with the different information students have input into their timelines. Various materials like cardstock papers, photographs, family pictures, index cards, maps, and using their Chromebook to gather information to complete their timeline will be provided. Also, various literature is used to help students comprehend more about the concept of time and distance—for example, a book name How Children Lived by Rice and Rice. The book talks about how children lived long ago while displaying a timeline. The additional book about the timeline gives students more examples of timelines.

For ELs and struggling students: providing templates for specific parts of what and how students want to create their timelines. They are providing the flexibility of their choice of timeline, whether horizontal, vertical, or circular, which will be students' options.

Assessment

A rubric scale of what component is required when creating a timeline is the assessment piece. Rubrics are created by the students based on what elements are needed in the timeline. The

teacher writes and adds to the rubric and discusses which elements are appropriate and acceptable as a rubric score. The rubric can be rated by a 1-4, 1-6, or 1-10 scale, depending on how detailed students choose to show performance.

Teaching Strategy – Cognitive Content Dictionary, Picture File Cards, and Periodic Table of Elements

Students are given vocabulary words that connect to the Periodic Table, like uranium, radon, hydrogen, helium, electron, neutron, nuclear energy, proton, atom, radiation, a radioactive atom, radioactive decay, radium, and uranium mining are words students need to know when teaching the unit. The teacher will construct a graphic vocabulary organizer for students to help them become familiar with the vocabulary. Displaying the words on a wall chart with the components of the word will help students like a Cognitive Content Dictionary (CCD). After students become familiar with the vocabulary words, the teacher begins the Periodic Table Chart activity. The CCD involves the student in metacognition (thinking about their thinking). The chart paper is displayed with the chosen word, and as a class, students and teacher analyze the word by making predictions, sketching a picture about the word, then writing a sentence using the word. Using this process and reviewing the word each day helps enhance students' vocabulary.

After the vocabulary, the teacher will distribute picture file cards of uranium past and present. The teacher will explain the uranium demand from the 1940s through the 1990s. During this period, thousands of uranium mines were functioning and shipped to areas needing ore. Many of the mines were operating in the western part of the United States. The picture file cards should interest students and be used for discussions about uranium. The cards can be used strategically for making predictions, new concepts, building vocabulary, explanatory or narrative writing, category, title labeling, classifying, evaluating, and justifying the visuals. About fifty to sixty pictures of various examples of uranium uses will give students an additional wealth of learning about the ore. Pictures like a nuclear power plant, fission of neutron splitting, submarines, armor plating, uranium mines, yellow cake, and miners working are examples of how the teacher can frontload and add background knowledge to the students.

After the picture file cards, the teacher models the usage of the Periodic Element Chart to students in how to analyze the parts of the element, symbol, like atomic weight, atomic mass, the atomic structure (electrons, protons, and neutrons), and the group family and structure which is created on a graphic organizer. The teacher and students, with guided practice, will complete the process of how to complete the graphic organizer when selecting an element.

Classroom Activities

Cognitive Content Dictionary, Picture File Card, and Periodic Table Chart

Students demonstrate the usage of the Cognitive Content Dictionary by completing a personal graphic organizer chart with the vocabulary word. Their CCD will be color coded for each word. Students use colored pencils to complete each word on the CCD graphic organizer. Afterward, students will conduct a carousel for each team and share their words with another team table. Finally, students choose one word as a signal word for the day. Signal word means the teacher or

student says and uses a word throughout the day. For example, the word uranium is used when students transition to other content, like reading to writing activities or leaving to lunch or elective.

The Picture File card activity is used when students are given pictures at their team table. The picture file cards are images that connect to the content, for example, anything and everything that deals with uranium. The images should not contain text because the photos will generate discussions, questions, observations, and wonder. The picture size ranges from five to twelve inches in width and height. Some pictures can be from National Geographic magazines because the photos in the magazine are vivid in color and have thicker paper quality.

Students are guided by a given activity, like using an observation chart. The charts begin with observation, and students tell what they see in their picture, then tell what they are wondering about, and finally, students answer their wondering questions with their peers. Each peers within the group share and talk about their pictures. The observation activity guides students to begin sharing, generate questions, and share them with the whole class. The picture file cards and the observation chart activity help students begin thinking about their learning.

The picture file card activity will lead students to the Periodic Table Chart to begin thinking about metals and their elements. Students will analyze parts of various metals like uranium, radon, radium, cadmium, lithium, and others on a handout. They must use the Periodic Table to identify the protons, neutrons, and electrons for each given element from their vocabulary list. Students will work with a partner when completing the element chart. After completing the chart, students chose four elements to make a 3D diorama for the four elements.

Student Assessment Plan

The assessment portion is students creating a diorama of four elements and are allowed to use any material to build their elements. They use miniature-colored marshmallows and toothpicks to make the protons and electrons. The green marshmallows can be the electrons because they have a positive charge, and yellow can be the protons. The white marshmallow can be the electrons because they are a negative charge. The diorama must hold together as a 3D figure and stand as a display.

A rubric scale will be used to assess students' creations. Additionally, requirements are to have labels for each part of the element. Below is a sample rubric for assessing students after completing the four elements.

Category	1	2	3	4
Quality of Construction	The diorama shows considerable attention to construction. The items are neat. All items are carefully and securely attached. There each other are no smudges or stains. Nothing extra; focus on the element.	The diorama shows attention to construction. All items are attached. A few barely noticeable smudges or stains are present. Extra hangings.	The diorama shows some attention to construction. Most items are attached. Most items are securely attached. A few noticeable smudges or stains are present. More hangings.	The diorama was put together sloppily. Items appear to be just "slapped on." Pieces may be loose or hanging over the edges. Smudges, stains, rips, uneven edges, and stray marks are evident.

Creativity	Several of the objects used in the diorama reflect an exceptional degree of student creativity in their creation and/or display	One or two of the objects used in the diorama reflect student creativity in their creation and display.	One or two objects were made or customized by the student, but the ideas were typical rather than creative	The student did not make or customize any of the items on the diorama.
Design	Objects are an appropriate size and attractive shape and are arranged well. Care has been taken to balance the diorama scene.	Objects are an appropriate size and attractive shape and are arranged well. The diorama, however, does not appear balanced.	Objects are an appropriate size and shape, but the arrangement of items is not very attractive. It appears there was not much planning of the item placement.	Objects are of the wrong size and shape. It appears little attention was given to designing the diorama.
Attention to Theme	The student gives a reasonable explanation of how every item in the diorama is related to the element. For most items, the relationship is clear without explanation.	The student gives a reasonable explanation of how most items in the diorama are related to the element. For many of the items, the relationship is clear without explanation.	The student explains fairly and reasonably how most items in the diorama are related to the element.	The student's explanations are weak and illustrate the difficulty in understanding how to relate items to the landform.

Teaching Strategy – Big Book

Big books are unique when used in the classroom because they address students' learning content. The teacher generates teacher-made big books. The big book helps student build background knowledge addressing high-content vocabulary and uses patterning concepts to help students comprehend the topic for a more extended period. A big book is a tool to introduce the subject and to hook students about the topic they are about to learn.

Also, the teacher and student's sense of authorship shows that teachers can create a book. The teacher providing examples of created big books helps students view examples of literacy and content made by someone familiar. Students can see their part in creating their big books. The Important Frame (The important thing about ___ is ____) helps students form their paragraphs to generate their big book. Students begin to think about a repeated phrase for their book. Photos from the National Geographic, personal photos, and collages of pictures can be added to the text. The number of pages depends on the context of learning or what the teacher requires for students to generate. The language of the text can vary Diné to English. When both languages are used, it is preferable to have the native language written first, then English.

Classroom Activities – Big Book

Students create a big book about a grandparent. They need to choose a grandparent that was affected by the uranium mines. The grandparent can be the actual miner, the wife and children affected by residing near the mine site in which their homes are contaminated, downwind. If students cannot find a grandparent, they may choose a grandparent who has some connection to uranium.

Students need to complete a grandparent interview sheet with questions. After completing the interview, they will begin working on the Important Frame paper. A repeating phrase for the big book is the key to focusing on how vital their grandparent is to the students. The requirements on the Important Frame are grandparent's birth, parents and siblings, education, marriage and family, job/employment connecting to the uranium mine, and current activities. Photos,

paintings, and drawings/sketches of the grandparent need to be included in the big book. A total of seven pages with three pictures for each page makes a complete big book. The seventh page is the author's page; the student creates a page about themselves.

Student Assessment Plan

Students will be assessed on the book's content, neatness, number of pages and pictures, and presentation of their big book. Students will read and share their big book with the class. The teacher will use a checklist of requirements when presenting their book.

Oral Presentation

Assessment Criteria
4. Proficiently skilled; consistently
3. Considerable skill; most of the time
2. Developing skills: occasionally
1. Beginning skill: seldom

Select the appropriate grade for each of the following. Use the assessment criteria above.				
1	2	3	4	Speaks in a clear and auditable voice.
1	2	3	4	Maintain eye contact, engage, and show enthusiasm.
1	2	3	4	Effective pacing, students do not rush.
1	2	3	4	Use presentation time well from beginning to end.
1	2	3	4	Effective opens and closes topic of presentation.
1	2	3	4	Show ideas and information step by step, easy to follow order.
1	2	3	4	Provide helpful visual aids to illustrate ideas.
1	2	3	4	Refers to specific details and examples where needed.
1	2	3	4	Ask questions to bring up ideas.
1	2	3	4	There is evidence of rehearsal and planning.

Strengths:

Suggestions for Growth:

Alignment with Standards

Arizona Science Standards

5.P1U1.1 Analyze and interpret data to explain that matter of any type can be subdivided into particles too small to see and, in a closed system, if properties change or chemical reactions occur, the amount of matter stays the same. Students compare chemical elements using the Periodic Table of Elements and create a diagram of the element.

5.P1U1.2 Plan and conduct investigations to demonstrate that some substances combine to form new substances with different properties and others can be mixed without taking on new properties. Students read, analyze, and compare the different toxic chemicals from mining uranium ore.

Arizona Studies Standards

Human-environment interactions are essential aspects of human life in all societies.
5.G2.1 Describe how natural and human-caused changes to habitats or climate can impact our world. Students read and explain how uranium impact Indigenous population and land when uranium mines provide employment on their lands.

Human-environment interactions are essential aspects of human life in all societies.
5.G2.1 Describe how natural and human-caused changes to habitats or climate can impact our world. Students read and justify how uranium provide nuclear energy to the global economy.

Cycles of conflict and cooperation have shaped relations among people, places, and environments.
5.H2.1 Use primary and secondary sources to summarize the causes and effects of conflicts, resolutions, and social movements throughout the historical timeframe. ▪ Key conflicts can include but are not limited to cultural conflicts, political conflicts, economic conflicts, military conflicts, and conflicts related to resource use and availability. Students read and create a timeline of the history of uranium impacts to Indigenous population.

Diné Standards

Concept 3 – Iiní (Hane' bóhooł 'ą'ígíí baa hashne' dooleeł) I will utilize the Diné language to present information in a variety of situations. PO 1. Baa yá'áti'ígíí ninásélkáa'go nát'ąą' baa náháshe' dooleeł. I will research a topic and give an oral report, after creating a Big Book about a grandparent (Cheii or Nalii).

Concept 3 - Iiní (Hane' bóhooł 'ą'ígíí baa hashne' dooleeł) I will utilize the Diné language to present information in a variety of situations. PO2. (Hane' áshlaayígíí bik'eh áásht'įįłgo baa hashn'e dooleeł. I will use appropriate facial expressions, gestures, or dramatizations to support my presentation, while presenting the Big Book created. Students share book with classmates and family members.

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