Clean Air and Water: Keeping the Navajo Nation Safe through a Clean Environment

Clean Air Healthy Lungs

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Introduction

I recall my dad smoking while driving home to try to stay awake. I remember the cigarette smoke meandering through the night and the odor lingering in the truck even though my dad did his best to blow the smoke out the open window. I remember the smell of cigarette burning my nostril, but couldn't say anything. In addition, each winter, my dad would start a fire in the wood burning stove every morning to warm up the house. I would wake up to the scent of wood smoke, followed by the smell of coal burning, but I would just snuggle back into the covers because it wasn't warm enough. Soon, you could smell coffee brewing, and bacon cooking. That was a sign that it was time to wake up and start the day. When my dad built the house, he did not include plumbing, electrical wiring, or any type of ventilation system. Since there wasn't any ventilation, the smell of smoke and the smell of cooked food lingered inside the house throughout the day. The propane from the stove was also problematic, especially as the last ounce of gas slowly leaked when the propane was running low. Mom knew that we had to turn it off, but she would turn it back on when it was time to cook. Coming from a low-income family, we could not afford to waste any necessity, such as the last ounce of propane. We were discouraged from opening the doors or the windows because my parents did not want let out the warmth, which basically meant that they don't want to burn more wood and coal than necessary. Furthermore, I remember my mom using Clorox or Pine Sol when it came to clean the house. These odors and particulate matter were just part of our everyday lives. During our adolescent years, my sister and I went through the "big hair" phase where we used tons of aerosol hair spray. As I grew older, my roommates in colleges were into scented candles and tons of air fresheners. However, there was definitely one scent I could not stand, perfumes and scented air fresheners. For as long as I remember, I associated certain scents with my childhood. At the time of our upbringing, we were unaware that these scents and odors were toxic and harmful to our health. Air pollution is everywhere, and as a child, you don't realize that one of the ramifications of poorly ventilated housing was the risk of polluting the indoor air quality.

Context

Kayenta is located in Northeastern, Arizona, on the Navajo Reservation right at the junction off U.S. Highway 160 and U.S. Highway 163. The town is located north of Black Mesa, East of Skeleton Mesa, and south of Toes Ridge, and 30 miles from Utah border. The town is gateway to Monument Valley, where tourists from all over the world drive through daily. Several restaurants, hotels, and one Bashas grocery store accommodate visitors. In addition, there is a post office, an Indian Health Service facility, and an airport for small planes. The town has two types of government: Kayenta Chapter which is a sub-tribal nation government, and Kayenta Township. The township is considered a municipal–style government, and is also considered a sub-government of the Navajo Nation. The Township consists of five elected officials who elect a town manager. The population of Kayenta is 5,189 people according to the 2010 Census. The population comprises of 92.27% Native American, 4.56% White, 1.97% Hispanic/ Latino, and the rest other Races. The Community also has two schools: Kayenta Boarding School, which is

part of the Bureau of Indian Education, and Kayenta Unified School District. Kayenta Unified School District is a public school that serves students from Pre-School through 12th grade that serves the community and other feeder communities within a 50 mile radius including Dennehotso, Chilchinbeto, Shonto, Black Mesa, and students who live south of the Utah Stateline. Some students who ride the bus spend up to an hour each way from home to school, and from school to home. There are four schools in the District: Kayenta Early Childhood Education, Kayenta Elementary School (KES), Kayenta Middle school, and Monument Valley High School. According to the June 19th, 2019 School Board Minutes, 1,698 students were enrolled in the school district. KES had a population of 526 students by the end of school. According to the Arizona Report Card, KES is rated as an F School. A majority of students in the grade depends on the ones who pass AZ MERIT at third grade, fifth grade, and Eighth grade. AZ MERIT is a summative assessment that the state of Arizona Department of Education uses to test for student proficiency level in English Language Arts and Math from third grade through high school. According to the 2017/ 2018 school year AZ MERIT scores, 70% of Third and Fourth Graders scored at minimally proficient, 13% scored are Partially proficient, 16% scored at Proficient, and only 2% scored at Highly proficient. In comparison, 56% of El/ FEP scored at minimally proficient, 39% scored are partially proficient, and 6% scored at proficient.

This unit is intended for my fourth grade students who were placed in a Structured English Immersion (SEI) program. Students who are in my class are considered English Learners, and they have a unique set of English Language Proficiency (ELP) Standards designed for them to follow, along with the Arizona State standards. The goal is to reclassify these students into general education classrooms within two years after they are identified. Most students are identified two ways. One way is that they specify that someone in their family speaks the Navajo language when they fill out the Primary Home Language Other Than English (PHLOTE). The second way is when the EL Director finds out through the Department of Education that that child had been in an SEI program at their previous school. These students get an intensive 4 hour English Language instructions focusing on five domains: the first hour is vocabulary/ Listening and Speaking, second hour is reading, third hour is language (grammar), and last hour is writing. However, the next school year, we are expected to cover the same standards into two hour blocks instead of the four hour blocks. The students are assesses yearly using Arizona English Language Learner Assessment (AZELLA). A student reclassifies as proficient if they score proficient on composite score, reading domain, and writing domain.

Rationale

Students in a structured English Immersion class are faced with a unique challenge. Most of the students in an SEI class are typically two grades levels below in reading compared to their peers. Most of the students struggle with grammar, vocabulary, writing, and especially reading foundation. At fourth grade, students are supposed to be reading to learn, but they lack reading foundation skills that prevent them from learning from reading texts. A majority of fourth grade school year is spent on learning how to read. Unfortunately, learning to read is very tedious for most students because the materials that are used for learning to read are basic, and do not engage the students. Based on observations, students are more engaged when they do hands on activities, experiments, and structured discussions.

There aren't any curriculms designed especially for EL students and SEI classrooms. Often, SEI teachers are expected to modify the General Education curriculums to meet the ELP standards. The curriculums for fourth grade is difficult and confusing for my students. I would rather create an intensive curriculum unit that meets the needs of my students utilizing Navajo Nation standards, Arizona State Standards, and ELP Standards, rather than spending time on curriculums that the students don't comprehend.

This curriculum involves students do hands on investigations as well as oral discussions. As a fourth grade teacher, the students consistently score low on listening and speaking on Arizona English Language Learner Assessment (AZELLA). In addition, every year, the students struggle with reading comprehension, and continue to do poorly on any formative and summative assessments. Most students cannot evaluate and synthesize comprehension questions for two reasons: one is that they have low vocabulary skills, and two, they literally cannot give meaning to the text. The objective of the curriculum is enhance student's interest in learning, and jump start their reading comprehension skills.

The challenge would be to come up with reading materials, as well as activities that would be relevant to EL students and SEI classrooms. I want to create a unit that will really benefit the students and help them start developing reading skills and implement reading comprehension strategies. This curriculum takes about 15 days at the most, teaching it for one hour each day, and will be taught during the science block.

Content

When we think of air pollution, most of the time, we think of outdoor pollution, pollution in cities, and pollution from power plants. Who thinks about the quality of air in our own homes? We often think of our homes as a safe haven, a place where we believe that there is no danger. I knew air pollution existed, but I associated that term with power plants, and big cities. The question is how much do students know about air pollution inside their own homes? Do they have ventilation? Do they still use wood stoves for heat? If so, how much smoke escapes? How much do *Volatile Organic Compounds* (*VOCs*) affect their daily lives? Do the live near mines, and how much radon is present? Does it have any effects on their health, do any family members suffer from asthma or emphysema? What are some other long term effects on their health? Do families know how to monitor ambient air in their own homes to check for certain pollutants like radon and particulates?

Níłch'i in Navajo Philosophy
Níłch'i is one of the four main elements of Earth; light, rain, and pollen are the others. Navajos believe that if you do not respect the elemental Níłch'i and your thoughts and words are bad, the sacred forces will punish you. The Navajo have a ceremony that restores harmony and balance with nature.
Níłch'i, (Air or Wind), began its existence since the birth of creation in the First World, according to Navajo Creation stories. The story of Níłch'i describes the attributes including its relationship with other beings and its existence as a Holy Being. According to McNeley (1981), "Wind has existed as a holy being from near the beginning of Navajo universe, being endowed

with the power to give life, and movement to other beings, and possessed of knowledge which it conveys to the holy people."

In the beginning, mist first gave the breath of life to the four sacred mountains. The mist of light arose from the four cardinal directions: Mist of Dawn to the east, Mist of Blue Sky to the south, Mist of twilight to the West, and Mist of Darkness to the north.

Níłch'i first appeared to the inhabitants of the first dark world as a cloud of light to the east. When the cloud turned dark, Dark Wind appeared. Blue Wind appeared right after the cloud turned blue. When the cloud turned yellow, yellow cloud came to the people. The white cloud created the White Wind. In addition, when the cloud turned multiple colors it created other beings including the Rainbow, White Early Dawn, Blue Sky, Yellow Sunset, and Dark of Night. Special times of day that the Cloud of Light created also hold special powers. In addition, when Níłch'i passed through the people, air became the first "food." The food of Níłch'i gave life, form, and strength to the people, and in addition life to the water and mountains. The Winds also created a Supreme Sacred Níłch'i who created other beings like First Man, First Woman, Talking God, and other Holy People.

In addition to Níłch'i making life possible through the miracle of breathing, it also guided and protected the people. Before Níłch'i became involved with the people, they often migrated from place to place, aimlessly, without any sense of direction. Furthermore, the people did not have a language to communicate with one another. The world itself was known as One Word because people only grunted one phrase, "whoo." Because Níłch'i saw the people struggling, he declared himself as a guide. He repeated to the people, "I will inform you" four times before thought started forming slowly in words and language. Since Níłch'i was living in each being, it used that connection to guide the people to start communicating with a language Furthermore, the same connection guided the people to a place to live, and guided the people to choose a leader. The people needed leadership and language as knowledge to lead themselves. Because of Níłch'i, the people now have leadership and words to communicate.

When people emerged to the current world from the other worlds, they emerged with Níłch'i and other holy people. Although Níłch'i emerged from the other world, Earth Woman placed the Winds in each cardinal directions like before, to continue to provide life and guidance, and close associatiation with language. In this world, however, special emphasis need to be place on the "relationship between Níłch'i, and the life and behavior of earth surface people." (McNeley, 1981, p.15)

The existence of 12 Níłch'i came into being when more Níłch'i were formed to influence human life and behavior. Two formed from earth, two formed from the water, and two formed from the clouds. Of the newly formed winds, 6 came from above, and 6 from below. These 12 Níłch'i effect human life differently; some cause difficulties and sickness. Revolving Wind, Coiled Wind, Striped Wind, and four additional winds are considered bad Níłch'i. Because the Earth revolves in clockwise fashion, and the sky moves counter clockwise, it causes a friction. The Earth surface people live right between the friction; and therefore the Winds affect the people negatively. (McNeley, 1981, p. 17)

This creation story explains how the harmful Níłch'i and the benevolent Níłch'i came into existence on earth. The existence of these Níłch'i influence life and behavior of the people. In other words, undesirable behavior traits is effected by certain aspects of Níłch'i that has the same faulty trait and health as in the people. It can be concluded that health involves a good relationship with the environment which include: correct functions of your own physiology, good character, and good trait.

Right conduct is an integral part of an ideal relationship with any supernatural powers. The Níłch'i was sent to the Navajos to deliver prescriptions of right conducts. The function of the Níłch'i is to govern our thoughts and behavior. Since the Níłch'i lives within us, it encourages us to think and reflect on our bad behavior. "The Holy ones are believed not only to prescribe right conduct to the Navajo by medium of the Wind, but also to enforce their prescription." (McNeley, 1981, p. 58) If we don't correct our behavior, even after numerous warnings, the counsels cease. When the Níłch'i stops redirecting us because of our stubbornness, bad things start to happen to us. It especially distresses our mental and physical health. The Níłch'i within us is weakened and can easily be provoked by the environment.

Air pollution

As early as 1500 BC, the Egyptians realized that respiratory disease was caused by the silicate dust produced by cutting stone for construction (Husain, 2012). Hippocrates of Cos, a Greek physician, also observed that certain air in mines and in the environment in certain trades caused adverse health effects (Sohki, no date). In the 13th Century, people began to fear that air pollution due to coal combustion emission caused illnesses and deaths. However, it was not until the 17th Century that serious discussion of the relationship between air quality and disease began to emerge. Improving air quality began only with the last century due to several incidents. In 1930, many cases were reported of people suffering from pulmonary attacks, and 60 people were reportedly killed by fog that contained multiple pollutants that included sulfur. Meuse Valley, Belgium was the site of a leading steel industry that had a high concentration of iron mills and smelter. It was one of the earliest known cases where there was a connection between air pollution and severe health problems (Sohki, no date).

In another incident, 20 people were killed when a lethal smog settled over the town of Donora, Pa. on October 1948. A cold weather inversion trapped a poisonous mixture of carbon monoxide, sulfur dioxide, and metal that came from the local steel plants, railroad yards, and Zinc mill. The Donora smog event was the worst air pollution disaster in U.S. history. Because of the disaster, the public realized that industrial pollution could kill, and began an environmental movement. It led to the Clean Air Act and regulations of pollution by the state and federal agencies (Dawson, 2017).

In 1952, many people suffered from respiratory illnesses in when a thick smog settled for over a week over London, England. Coal-fired plants for electricity and heat, and diesel-powered bused contributed the most to the "Great Smog." Since the Great Smog, the United Kingdom enacted stricter air pollution laws (Dawson, 2017).

In 1955, the United Stated began federal air pollution regulations through the Clean Air Legislation. The Air Quality Act (1967) which became the Clean Air Act (1970), and additional amendments led to the development of National Ambient Air Quality Standards. The primary concern was to protect health, and secondary concern was to protect public welfare. This inferred that secondary standards were more stringent, but primary standards were to have immediate priority. The guidelines were based on health effects of susceptible populations. The Environmental Protection Agency has provided funding to research the chemical compounds of ambient air which resulted in a list of hazardous organic chemicals that are commonly found in

it. (Brooks & Davis, 1992, p. 3) Because of all the effort by all agencies, the air quality in the United States have led to increased understanding and capabilities, and public awareness.

Indoor Air Quality

As outdoor air quality began to improve, interest in indoor air quality began to emerge. Although many indoor pollutants come from outside sources, the most concentrated indoor pollutants come from the structure, the furnishing, and activities inside the structure. One of the main concerns is the limited ventilation in buildings. Lack of ventilation increases pollutant concentration which often leads to health problems. Just like Outdoor Air Quality, the concern for Indoor Air Quality became a health issue through historical events. Housing materials were exhausted during World War II. So after the war, synthetic materials were used as building materials to meet the demands of build shortages and housing shortages. The synthetic materials were preferred due to their fire retardant characteristics. The health effects were not considered. Secondly, the 1970 energy crisis was a major contributor to indoor air quality. To conserve energy during the crisis, the buildings were sealed to prevent outdoor air from entering the buildings. New equipment were designed and installed to condition and recirculate indoor air to cut costs of heating and cooling. Again synthetic materials were used. Third, as technology advanced, more office equipment were brought into homes. Many of the technology were installed into homes without adequate ventilation. In addition, the ability to detect even the lowest level of chemical in indoor air quality has redefined the importance of indoor air quality, especially since medical research has correlated chronic health problems to long-term exposure to low levels of IAQ. Furthermore, more people spend most of their time indoors because of their occupations (Sundell, 2004).

What causes indoor air quality? Indoor air quality could easily deteriorate depending on the rate at which contaminates are produced. Numerous chemicals, biological, and physical agents contribute to indoor air pollution. More than 900 compounds have been identifies in indoor air. In addition, reaction products form as they combine with other pollutants. Physical factors such as temperature, humidity, lighting, vibration, and noise also contribute to indoor air pollution problems. Inadequate ventilation systems often contribute to health effects from poor indoor air quality. Indoor air contaminates are classified into seven pollutant class. First, combustion products include carbon monoxide, nitrogen dioxide, sulfur dioxide, carbon dioxide, and tobacco smoke components. Volatile organic chemicals include pesticide components, fungicide components, various forms of alcohol, various forms of aldehydes, and many more. Respirable particulates include building materials such as asbestos, fiberglass, inorganic dust, and metallic dusts. In addition, pollen, paper dust, and organic dusts. Respiratory products include water vapor and carbon dioxide. Other pollutants include biologics and bio aerosols such as molds and fungi, bacteria, protozoa, and viruses. Radionuclides include radon and radon progeny. Odors are also considered pollutants (Environmental Protection Agency, no date).

Volatile Organic Compounds

Building construction materials and interior furnishings produces various volatile organic compound emission, especially in new or renovated buildings. Emission of Volatile Organic compounds is highest in new or renovated buildings. Materials used into indoor environments

become point source pollutants. Organic solvents used in paints, coatings, and fabrics release massive amounts of contaminants slowly and continuously over months and even years. Other compounds include paints, adhesives, carpeting, vinyl composition tile, flooring product, caulks, glazing compounds, and insulations. Some materials like carpeting, textiles, and insulations act as sponges or absorbents, and rerelease VOC into the environment. Release of VOC is determined by interaction between point source emission, ventilation effectiveness, chemical reactivity, human activity, and surface absorption. Temperature has a direct effect of emission rates from materials. (Brooks & Davis, 1992, p. 25)

Asbestos is not a single material, but refers to several inorganic silicate materials. Natural deposits of asbestos ore are found around the world, including the United States. Asbestos ore is crushed to separate from other minerals. The pure raw asbestos were often added to paper, felt, cloth, or rope. It was often mixed with cements, drywall compounds, plastics, paints, sealants, and adhesives. Asbestos was widely used between 1940's and 1980's for its fireproofing quality. It was often used in hospitals, schools, residential and commercial buildings. Asbestos Hazard Emergency Response Act (AHERA) of 1986 and the United States legally recognize 6 types of asbestos that fall into two categories. The first category is amphibole asbestos that include: crocidolite, amosite, anthophyllite, tremolite, and actinolite. The second category is serpentine asbestos that includes chrysotile (asbestos.com.) Although not all asbestos are considered dangerous, they are all regarded with the same fear as the more dangerous amphibole minerals: crocidolite and amosite. As long as the as the asbestos is not disturbed or material containing asbestos does not break down, it does not have an effect on indoor air quality.

Office equipment are point source for many VOC emissions and particulates. Ethanol, methanol, ammonia, formaldehyde, and acetic acids are just a few types of pollutants that are emitted from office equipment. Heating and cooking appliances that are unvented or leaky are sources for indoor combustion pollutants. Common Office supplies such as correction fluids or rubber cement emit naphtha, toluene, and acetone pollutants. Just like building materials, the newer the equipment, the higher VOC emission rate.

Just the presence of humans in a building can significantly alter the indoor air quality. Human bio-effluents, contaminates generated by the human body, have been a major Indoor Air Quality concern. The offensive odor adds Carbon dioxide, water vapor, and other microbes to the indoor air.

Environmental Tobacco Smoke

Smoking has a huge impact on indoor air quality because it introduces high levels of pollutants. Tobacco smoke is associated with numerous toxic gases and particulates. In addition, the tobacco smoke interacts with other pollutants to enhance the toxicity. Unfiltered smoke emit numerous pollutants including acetic acid, acetone, ammonia, CO_2, CO, ethane, and many more. The smoke coming directly from the tobacco is more hazardous because it contains concentrations of toxic materials 100 -1000 folds higher than the smoke inhaled by the smoker. Ironically, it is one pollutant that could easily be eliminated from indoor air quality.

Cooking in poorly ventilated buildings, and use of certain appliances may introduce CO, CO_2, NO, NO_2 and SO_2 into the indoor environment. Food products that go bad and grow mold also have an impact on indoor air quality.

Biological Agents

Louis Pasteur was the first to recognize that biological agents contribute to indoor air pollution. (Brooks & Davis, 1992, 31) We are surrounded by viable and nonviable microorganisms everywhere we go. Biologics found in homes include algae, anthropods, bacteria, fungi, pets, plants, protozoa, and viruses. Initially, the microorganisms establish themselves outside the home; in outdoor air, any source of water, other humans, foodstuff, plants, or pets. Eventually, the biologics make their way into residential structures. Residential structures offer optimal environments for bacterial growth. The three requirements for optimal growth of microorganisms include; the right temperature, the right humidity, and the right physical and nutritional surface area. In homes, nooks and crannies of the HVAC system, fiberglass duct lining, stagnant water in humidifiers, and old filters offer optimum environment for microbials to grow. Moist materials such as textile fabric, soaps, and plants area ideal areas for microorganisms to grow. In addition, humid areas such as restrooms, basements, shower heads, and areas that experience leaking, and flooding become optimal environment for bacterial growth.

Radon

Radium, a byproduct of decaying uranium, decays to radon. Radon is found in all rocks and soil that eventually leaks out as a noble gas when the right environment presents itself. When the gas escapes from the rocks and soil, it enters into the air or dissolves into surrounding water. The rate at which radon diffuses and enters into homes depends on geological factors that include soil permeability. Soil permeability is the property and ability of soil to transmit through air and water. Risk for radon exposure depends on radon concentration and gas permeability. These factors determine rate and movement of radon through the soil.

Radon is the highest single source of background radiation. Residential homes is the primary source of radon exposure. Radon enters the home through air that defuses from the "underlying soil by the "stack effect" phenomenon." (Brooks & Davis, 1992, p. 33) The stack effect is the ability of warm air to rise than the surrounding ambient air. In residential homes, when the air is warmer on the inside, radon seeps into the structure through gaps and openings, and allows the warm air to carry it throughout the home. Other ways that radon enters into the home is through water and gas utility, and certain building materials. Although EPA have guidelines for radon in homes and office buildings, more than a million people are exposed to radon that is comparable to uranium miners.

Physical Factors

Physical factors have a huge impact on indoor air quality. Temperature has a profound impact on indoor air quality. In general, the comfort range is between 69˚ - 79˚ F, depending on activity, clothing, and relative humidity. Temperatures higher than the comfort range has the

potential to release and emit VOC from materials. It is recommended to keep temperatures in the lower levels to prevent out-gassing, and prevent feelings of lethargy.

Humidity is another physical factor that could affect indoor air quality. Although there is no agreed upon Relative Humidity (RH), EPA suggests RH between 45% - 50%. RH above 70% could trigger microbial growth and contamination. RH below 20% is too dry, and could lead to dry nose, dry skin, and peculiar dermatitis.

Artificial lighting also contributes to indoor air quality. Inappropriate lighting, inadequate contrast, and excessive glare could lead to eye strain, eye irritation, and headaches. To prevent eye strains, ventilation rates need to be adjusted, control ultraviolet brightness, and reduce flickers in florescent lamps.

Vibrations and noise are physical factors that have attributed to indoor air pollution. Amount of vibration on desks have been known to cause dizziness and irritability. Noise levels above 120 decibels can also cause dizziness and nausea. Low frequency noises from HVAC are also known to cause problems.

Health Effects

Indoor air pollution effects human health through persistent lung diseases. Cancer, emphysema, fibrosis, and chronic bronchitis have been associates with indoor air pollutants that have been inhaled. Health effects does not depend on just exposure, but the dose of the pollutant that was received. Helen-Koch-Evans Postulates is an inference tool that determines the criteria for establishing cause and effect relationship between indoor air pollutant and overt disease. "Assessing the health effects of indoor air pollutants is complicated further because some pollutants exert different effects at different concentrations or durations of exposure." (Brooks & Davis, 1992, p. 53)

Biological consideration

The lungs because of its purpose and design is the only organ that has the most direct contact with environmental air pollutants. An adult breathes in about 10,000-20,000 liters of air per day, which is much greater than the amount of water and food we eat. Furthermore, the amount of air we breathe increases with exercise. Unfortunately, our lungs cannot discriminate the air and materials we breathe in. Air pollutants can cause direct acute and chronic health effects in the lungs. The health effects depends on the pollutants we inhaled, the deposit site in the lungs, and which clearance mechanism is involved. Air pollutants can absorb from the respiratory tract to other organs through the blood stream. The absorption depends on the reactivity of the pollutant, water solubility, and lipid solubility. It's important to protect the lungs because the function of the lung has many responsibilities which include gas exchange, temperature adjustment, humidity adjustment, contaminant clearance, etc. The lung responds to contaminants in many different ways: irritation of air passage, damage to cell lining of air passage, production of fibrosis, constriction of airways through allergies, and production of primary lung tumors. The respiratory tract is divided into three different parts: nasopharynx, tracheobronchial, and pulmonary. The type of pollutant deposit and production of biological effect is unique to the

different parts of the respiratory tract. The nasopharynx include the nose, mouth, oropharynx, and larynx. It clears pollutants through production of mucus, sneezing, and blowing. The tracheobronchial include trachea, bronchi, and bronchioles. Pollutants is cleared through production of mucus and coughing. The pulmonary include respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli. It clears pollutants through dissolution and phagocytosis.

Other Health Effects

Despite an overwhelming concerns of poor indoor air quality, health effects associated with exposure to indoor air pollutants is hard to diagnose and manage. Nature of the pollutant, pattern of exposure, population exposed, acute effects, and chronic effects need to be considered. The nature of the pollutant responsible for health effects may be hard to pinpoint because exposure occurs in mixtures of chemicals. Patterns of exposure may appear anywhere, in random, and unpredictable patterns. Exposure could happen at home, work, or outdoor environments. Population exposure refers to exposures that involves a large number of people, including susceptible population, who are not directly exposed in a work environment. The onset of clinical attributes of acute effects depends on many factors that include; pollutant mixture, exposure route, duration of exposure, preexisting disease, age, lifestyle. Chronic effects is often the hardest to diagnose due to the long term exposure to low level mixture of chemicals found in indoor air.

One major form of cancer associated with poor indoor air quality is respiratory cancer. In the United States, about 100,000 deaths per year is related to lung cancer, especially middle aged people. Inhaled toxic chemicals include: tobacco smoke, radon, fibers, organic particulates, and volatile organic compounds. Cigarette smoking has been linked to respiratory cancer. The relationship has been established through experimental, epidemiological, and clinical evidence. (Brooks & Davis, 1992, p. 61) Smoking indoors "increases the airborne levels of carbon monoxide, nicotine, polycyclic aromatic hydrocarbons, acrolein, nitrogen dioxide, respirable particulates, and other substances." (BROOKS & DAVIS, 1992, p.62) Side-stream smoke, which refers to smoke that is release from the cigarette directly to the environment, contains high levels of toxic and carcinogenic compounds. The link between Second hand smoking or passive smoking, and cancer, however, has mixed results. The only strong link between environmental tobacco smoke (ETS) and smoke among nonsmokers is when exposure occurred during childhood and adolescence.

Respiratory cancer has also been linked to radon, especially for uranium miners, and other underground workers. Radon gas is always present in the air, but the concentration are usually 5-10 greater indoors. Alpha particles, released by radon daughters, "penetrate the epithelial lining of the lung and damage the genetic material of basal cells." (Brooks & Davis, 1992, p. 63) The main concern is that radon causes cancer both to smokers and nonsmokers alike. Unfortunately, the little data presented are based on mathematical computation of risk estimations based on high exposure mining populations.

Under the right exposure conditions, fibers, especially asbestos, may cause cancer. Asbestos is carcinogenic and can cause health effects. The size of the fiber and aspect ratio are important factors in determining the carcinogenic effect of the fibers. Mesothelioma and bronchogenic

carcinoma have been linked to asbestos and certain other fibers. Studies show that bronchogenic carcinoma is caused by the interaction or "synergistic effect of asbestos exposure and cigarette smoking."(Brooks & Davis, 1992, p. 64) In other words, respiratory cancer caused by fibers alone is different than cancer caused by the interaction of a fiber and inhaled toxins. Is it necessary to remove asbestos from buildings? Studies show that the risk for health problems arising from low levels of asbestos present in homes, schools, and buildings. Asbestos removal is costly, and removal create more hazard. "It is essential that the concentration of asbestos, type of asbestos, and size and fiber aspect ratio be considered when evaluating for potential health risks associated with it." (Brooks & Davis, 1992, p. 64)

Organic particulates, combustion products, and hydrocarbon fuels in vehicles can find their way into homes. Organic particulates contain substances such as nitrated polyaromatic hydrocarbons, chlorinated dibenzodioxins, and dibenzofurans. These compounds are often released from incinerators and diesel engines. According to evidence, organic compounds are known to cause respiratory cancer in occupational work setting. However, the risk for cancer from organic compounds in residential settings and work settings have not been proven, especially the effects on indoor air quality.

Evaporated volatile organic compounds (VOC) is the main source of IAQ and the most active indoor air contaminant. Even low levels of VOC found in homes can cause acute and chronic health risks. Benzene, formaldehyde, trichloroethylene, polychlorinated biphenyls, and certain pesticides are examples of carcinogens. Concentrations of VOC that cause cancer is much higher than found in homes. Formaldehyde is the most common VOC found in homes because it is often used in building materials. Formaldehyde often effects the airways when it is inhaled through the lungs. The irritation and allergy appearance from formaldehyde exposure depends on the concentration in the air. The correlation between formaldehyde and cancer appear in only certain studies. However, formaldehyde is considered a potential carcinogen based on "large population exposure and epidemiological and toxicological studies, both by U. S. Environmental Protection Agency and Occupational Safety and Health Administration." (Brooks & Davis, 1992, p. 66)

Chronic Obstructive Pulmonary Disease (COPD) is one of the leading causes of death in the United States, and one of the leading reasons for premature retirement. There are three sub types of nonimmunologic COPD that effect different parts of the lungs: bronchiolitis, chronic bronchitis, and emphysema. Bronchiolitis effects the small airways in the lungs, while chronic bronchitis starts at bronchi, but eventually works its way to bronchioles. Emphysema effects the alveolar region of the lungs. Association between indoor air pollutants and COPD exist, but there is no evidence that indoor air pollution causes COPD, with the exception of environmental tobacco smoke (ETS) and asbestos. There is no doubt that the structure and function of the lungs are compromised by wearing down elastic fibers and damaging protease inhibitors, and prevent damaged lungs from recovering.

The primary risk factor for COPD is active smoking. "A growing body of medical date indicates that the most likely connection between indoor air quality (IAQ) and COPD is the effect that ETS and irritant gases on the respiratory illnesses (bronchitis and bronchiolitis) and lung development in children." (Brooks & Davis, 1992, p. 66) However, the evidence is minimal on

the effects of ETS and irritant gases on adults. On the other hand, light smokers and nonsmokers who are chronically exposed to ETS experience similar health risks. In addition, ETS is believed to cause COPD. In high concentration, Nitrogen dioxide, sulfur dioxide, and ozone are known to cause damages to the lungs. These gases are often found in both indoor and outdoor air, but levels of NO_2 are at higher concentration indoor than outdoor. In laboratory studies, NO_2, SO_2, and O_3 reduced immunity, structure, and function of the lungs. Furthermore, "susceptible population, such as asthmatic, may experience significant increases in nonspecific inflammation and airway resistance." (Brooks & Davis, 1992, p. 67)

Exposure to respiratory particulates such as fibers, dusts, and other particulates may lead to morbidity and mortality. Work-related exposure to fibers and particulates often lean to adverse pulmonary effects. Breathing in high concentration of inorganic particulates and organic particulates lead to health consequences. Some inorganic particulates include silica, asbestos, and hard metals. Examples of organic particulates include coal, grain, wood, and microbial chemicals. Concentration in indoor air depends on ventilation systems, cleaning, tobacco smoking, renovation and remodeling activities.

The most common particulates encountered often is asbestos. Asbestos is not dangerous as long as it is not disturbed because the particulates it releases does not exceed ambient concentration. However due to reaching a controversial conclusion about the danger of asbestos, disturbance from liberal removal of materials and pipes containing asbestos reach dangerous levels. Inhaling asbestos fibers cause chronic lung disease called asbestosis. Symptoms do not appear until after 10 to 40 years. Long term exposure causes tissue scarring and shortness of breath. Additional symptoms include persistent dry coughs, loss of appetite, clubbing of fingernails and/or toenails, and tightness of the chest. The people who are most at risk are the personnel who remove asbestos.

Fiberglass is another particulate often found in most workplace environments. Fiberglass is used in textiles, fabrics, and linings for ventilation ducts, and insulations. It is also used to reinforce paper, plastic, and rubber to strengthen it. The connection between fiberglass and COPD is insignificant. However, it is known to cause outbreaks of rashes, itching, and respiratory irritation.

Respiratory particulates cause health complications, especially the ones that stay suspended in the air is in higher concentration than outdoor environment. Most respiratory particulates are common in industrial environment. Some examples of respiratory particulates include tobacco, and disturbances of particulates from cleaning and renovation. Although there is minimal research on the connection on respiratory particulates and impact on human health, minimal concentration can cause occupational discomfort. Prolonged exposure to respiratory particulates in indoor environment can be a risk factor for COPD.

The health effects from volatile organic compound(VOC) depends on the toxicity of VOC, route of exposure, acute dose of VOC, individual susceptibility, and VOC ability to react with other chemicals. VOC is a respiratory irritant that effects the respiratory system. VOC are found in high concentration in indoor air. Formaldehyde is the most common VOC found in indoor air.

However the role of VOC producing COPD in healthy individuals is very insufficient. In healthy individuals, the concern that VOC causing COPD stems from the fact that it repeatedly irritates respiratory tract that often results in bronchitis. Additional symptoms of repeated exposure to VOC are chronic coughs and mucus productions. Respiratory health can be effected to low level exposure to VOC. Eyes, nose, and throat irritation are symptoms to VOC exposure. However, "there does exist a very real association between indoor air pollution and COPD," especially those with preexisting COPD. Preexisting COPD causes changes to a person's interaction with indoor and outdoor pollutant. Changes occur in the respiratory tract where the pollutant was first deposited. Secondly, COPD changes how it retains pollutant in the respiratory tract. In addition, clearance of pollutant from respiratory tract is compromised. Finally, COPD changes physiological response to inhaled pollutants.

Infectious disease and microbial toxins are easily transmitted between people, especially indoor. When we inhale air through our respiratory system, it often carries pathogens and pollutants. Most of the time, the respiratory system often clears out the lungs. Other times, it causes an outbreak of infectious disease, allergy, and irritation. Transmission depends on presence of susceptible population, sufficient concentration, and plausible route of exposure.

Obligatory parasites are airborne illnesses that are transmitted from person to person in poorly ventilated or crowded indoor environment. The disease include influenza, rubella, measles, and chicken pox. Most diseases require human reservoirs, and only a few require environmental reservoir. Fungi is an example of an disease that transmit through the air, but still effect health, as well as compromised hosts, and can cause building related illness. Fungi is "responsible for systematic mycotic infections, or mycoses, such as blastomycosis, coccidiomycosis, and histoplasmosis." (Brooks & Davis, 1992, p. 70)

Opportunistic parasites organisms may cause diseases to individuals with preexisting medical conditions, such as COPD. Healthy individuals often resist opportunistic pathogens despite the level of exposure. These pathogens often find environments that allow them to preserve or to amplify. HVAC systems are ideal places for microbial growth. Sometimes, iced and chilled water storage systems provide unexpected environments for some parasites. *Legionella pneumophilia* is a common opportunistic parasite that is spread through indoor air. Legionella bacteria requires oxygen to survive, yet, it is often found in water. Desired environments for this bacteria include cooling towers, evaporative condensers, steam created by water in showers and drinking water (Centers for Disease Control and Prevention, 2018).

Legionnaires' disease is one example of airborne disease that comes from *Legionella pneumophilia.* It is a progressive bacterial pneumonia that spreads through mist or steam, or other tiny droplets of water that are breathed into one's lungs (Centers for Disease Control and Prevention, 2018). Symptoms include confusion, abdominal pain, vomiting, diarrhea, muscle aches, coughing, fever and chills, and headaches, and can be serious. Pontiac fever is another sub category disease that is a subset of the pathogen, *Legionella pneumophilia.* It is relatively mild case of non-pneumonic disease that causes nausea, diarrhea, sore throat, and dizziness Centers for Disease Control and Prevention, 2018).

Toxins become one of the indoor air pollutant when some species of bacteria die and release endotoxins. Humidifiers and other indoor environment act as reservoirs for these toxins. Some symptoms associated with endotoxemia include fever, shock, vascular effects, and hemorrhage. In addition, fungi and molds produce mycotoxins. Mycotoxins are capable of causing disease and death that result in potent liver and systemic toxins. Low levels of mycotoxins in low levels may cause immunosuppression, gastrointestinal symptoms, reproductive toxicity, and neurotoxicity. Molds on the other hand are potent enough to be considered for chemical warfare. Transmission of infectious diseases in indoor air depends on many factors including genetics, physiology, mechanical integrity, and age of the host. Environmental factors also tend to influence the outcome of infectious disease. Often, environmental factors reduces the viability, and virulence of the airborne disease. When the lungs are damaged by pollutants such as nitrogen dioxide (NO_2) and ozone (O_3), the lung becomes more susceptible to infections, it limits the lung's immune system. Exposure to these oxidants damages the lung's ability to dispose of inhaled microbial particulates, clear pulmonary surfactants, and prevents unnecessary inflammation and immunity response. There is a strong association between indoor air and infectious disease. Indoor environment create two risk factors in transmitting infectious diseases. First, it provides indoor reservoirs, and provide conditions that enhance transmission of the disease. Secondly, indoor environments provide a source of exposure to pollutants. Preventative measures can be taken to minimize transmission of infectious diseases: appropriate design, installation, and maintenance of HVAC systems is important, control humidity to 30% - 50%, providing effective filtration, and adequate housekeeping.

Strategies

Vocabulary

Due to the background of home and school experiences, students in my classroom still struggle with vocabulary. Many prefer to stay in their comfort zone when they communicate through conversations and through writing. Often, they revert back to familiar words and familiar phases, especially if vocabulary is taught as a direct instruction. Most of the time, it effects their reading comprehension when they read, especially when they read informational texts. Vocabulary development is crucial for all students, especially for English Learner. This unit provides an opportunity for students to learn content rich vocabulary. "Rapid and large growth again suggests that a significant amount of vocabulary learning takes place through incidental or environmental learning, from wide reading, discussion, listening, and media, for example, rather than from direct instruction. We learn from interacting with and using works in meaningful contexts." (Blachowics & Fisher, 2002, p. 5.)

Content rich vocabulary instruction would include using pictures, watching content related short videos, labelling diagrams, and annotations.

Concept Map

Because there are is so much information that students need to learn Indoor Air Quality, they will need a way to organize all the information. One graphic organizer that students will utilize is concept maps compare and contrast relationships between concepts. Graphic organizers uses

columns and rows to organize concepts in the left column and characteristics in the top row. Using the characteristics as a guide, students will research their concepts in the texts they read. Students will fill in one concept chart together, but a group of students will be assigned a concept to look up. Once the chart is completely filled in, students will look for similarities and differences between the concepts, as well as noticeable patterns. Students may formulate questions on other information that they may still want to know about.

Hands-On-Experiments

Experiments and hands-on-activities are valuable in the classrooms for two reasons. First of all, hands on activities are highly engaging activities that encourage learning. Secondly, English Learners do not do well with direct instructions and I believe that students will learn better when they do experiments that relate to the unit. Some experiments that students will do include: a game to teach them how cilia work in their lungs, an experiment that teaches them about temperature inversion and possibly that hot air rises and cold air sinks, especially indoors, and catching particle pollutants to help them realize that the air they breathe is not always clean, and to help them realize that particles they found on the milk cartons are pollutants in indoor air.

Activities

The Cilia (not Silly!) Game

The students will observe through role playing how our bodies (cilia) help protect us from particle pollution, especially healthy lungs. Prior to the game, students will read a short passage that summarizes the function of the lungs, and how it protects itself from particulate pollutants. Students will learn that particulates can affect people's health.

In this activity, the classroom will be darkened. Throw a handful of flour into the air (away from student) and quickly shine a light on the falling flour. Ask the students: *what do you see? What are the tiny pieces called?* Discuss the floating flour, and explain that it represents particulates. Because we don't often see particles, we inhale it into our lungs. Particle pollution is when dust, dirt or smoke is mixed with liquid droplets in the air. When people breathe in a lot particle pollution, they can get sick.

Tell students to draw a large circle. The circle will represent a strand of hair with a "diameter of 70 macron.) Draw two tiny circles inside the larger circle and label that 2.5 macron. Macron are very small units of measurements. Particles are very tiny and cannot be seen by the eyes, but they are still there. Explain the cilia are tiny hair-like structure in our respiratory system. The job of the cilia is to protect the respiratory system by keeping particles from entering our lungs.

In the second part of the activity, two students will act as "lungs," about a little over half of class as "particle pollution," and the remaining students as cilia. Use name tags or colorful vests to identify the roles that students are playing. The lungs and cilia organize themselves in a trapezoid shape. Use cones to represent the outline of the lungs. The "lungs" will be at the short end of the trapezoid, and "cilia" will be scattered inside the trapezoid between the lungs and the particle pollutants. The "particle pollutants" will have balled up socks to represent particles. The

"particle pollutants"' will aim for and try to hit the lungs. The cilia will stand in place, but will prevent the balls from hitting the lungs by batting the socks away.

In the first round, the "particles" will be thrown one at a time. When all the particles have been thrown, ask the lungs how it felt to have particles thrown at them. Then ask them how many particles have reached them? Ask the "cilia" how they felt during the game.

In the second round, the "particles," increase the number of particles will be thrown quicker and at the same time. Ask the same questions from above. What were the results? Was it much easier or harder for the "cilia" to keep the particles away? How many particles reached the lungs?

In conclusion, explain that everyone can be effected by particle pollution, but some people, especially the elderly, children, and people with pre-existing conditions are more sensitive to particles. Discuss some of the symptoms including coughing and difficulty breathing. In the end, discuss what the students can do to protect themselves. (AQI Toolkit for Teachers Grades 3-5, p. 46-47)

Temperature Inversion

The activity for *Trapping Air Pollution: Temperature Inversions #1* will demonstrate temperature inversions and its effect on pollution. The students will observe and define temperature inversion my simulating normal weather conditions compared to conditions during temperature inversions. They will use what they observed to explain how temperature inversions can trap air pollutants and impact health.

Before the activity begins, students will compare two photos of the same city, but one with "clean air" and the other with trapped air pollutants. The students will make prediction about the experiment.

The teacher will place two jars in a shallow pan. One jar will be filled with hot water and the other jar will filled with cold water (no ice if ice was used to cool the water). Place several drops of red food coloring to the jar with the hot water to represent air pollution. Place an index card over the jar with the cold water and quickly flip it over the jar with the hot water. Align the jar opening and remove the index card carefully.

As before, place two jars in in a shallow pan. Fill one jar with hot water and the other jar with cold water. This time, put blue food coloring in the cold water to represent pollutants. This time place the index card over the opening off the hot water and quickly flip it over the jar of the cold water. Align the index and carefully remove the index.

Carefully observe both experiments. Ask students, what happened in each experiment? Which of these experiments reflect normal weather conditions, and why? Which reflect temperature inversion? What happens to air pollutants under each of these conditions and how do you think this might affect people's health? (AQI Toolkit for Teachers Grades 3-5, p. 61-62)

Catching Particle Pollutants

The objective for this activity, the students will discover ways to determine that the air is polluted. In addition, students will categorize that air pollutants can be both particles and gaseous. Finally, the students will be able to define air pollution.

Before the experiment begins, ask students questions to activate prior knowledge or set the stage for the activity. Ask the students the following questions; is the air always clean? When is the air dirty, what is called when the air is dirty? What do we call the substances that make the air dirty?

Have the students observe the air outside. Make sure they write down anything they observe. Encourage students to make their observations such as sense of smell, sense of touch, and sense of sight. Does it smell the same way like after it rains? Is the air clear or hazy?

The students will collect particle pollutants during this experiment using simple "collectors." The students will use double sided tape and wrap it around a milk carton. The students will mark the four directions on each side of the carton. The catchers will be numbered and placed in various spots around the school. Students will use compasses to make sure that the directions on the carton corresponds with the directions. Students will use a map to show where they placed the collectors. Students will be encouraged to make predictions.

After a few days, the catchers will be collected. Each carton will be observed carefully to determine what kind of particulates were collected on the cartons. From which directions did the most particulates appear? Which room yielded the most particulate matter? Use color coding to determine which rooms had the most particulate matter? Is the air clean in our building? (AQI Toolkit for Teachers Grades K-2, p. 27-28)

Assessments

Observations

The students will be assessed using classroom observations. Observation is a formative assessment. The students will draw their own predictions and conclusions based on the background knowledge read by the students and discussions in class. The assessments will be based on student participation and contributions to group discussions. In addition, the observations will allow me to see if students truly understand the concepts I taught. This will also allow me to redirect the students or even reteach the lesson if I believe that the students did not learn the objective. The students will write down their observations, predictions, and conclusions in a journal. The written predictions and conclusions will also be assessed.

Open-Ended Questions

Open-ended questions for two reasons. I want to know what students have learned overall from the unit. In additions, can they draw conclusions based on the knowledge they accumulated throughout the unit? With open ended questions, the students don't have options for answers,

and it does not allow students to guess their answers. With open-ended questions can elicit discussions and inquiry about the subject matter. Because students dread writing, I want to give the options of having students have oral response.

Presentations

Students will be given an experiment to work on as a team with guidance from the teacher. At the end of the experiment, students will draw conclusions. In additions, the students will create presentation boards and present to the other students in class. The presentation will utilize the scientific method which will include: question (objective or what do I want to learn), hypothesis (prediction – what I think will happen), experiment, analyze (what happened in the experiment?), and results/conclusions.

Standards

Vocabulary

4.L.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 4 reading and content, choosing flexibly from a range of strategies. This unit provides many opportunities to introduce grade level science vocabulary, vocabulary they will need for comprehension.

Life Science Standards

4. L4U1.11Analyze and interpret environmental data to demonstrate that species either adapt and survive, or go extinct over time. The following science standard will allow me to go into depth teaching about indoor air pollution. Students will learn that environmental pollutants play a huge role in keeping healthy lungs.

Reading Comprehension

One of the weakness for my students is that they always have difficulties with reading comprehension, especially if it is related to informational text. This unit will address the following state standard: 4.RI.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

Diné Standards

The students will be able to relate to the story about Níłch'i and how it relates to respecting nature, and keeping our lungs health. Concept 2: PO 3 I will retell stories related to elements of nature.

Resources

Join Our Pest Patrol: A Backyard Activity Book for Kids on Integrated Pest Management https://www.epa.gov/safepestcontrol/join-our-pest-patrol-backyard-activity-book-kids-integrated-pest-management

AQI Toolkit for Teachers Grades K-2(n.d.). Retrieved from https://www3.epa.gov/airnow/teachers/toolkit/teachers-toolkit-intro-k2-508.pdf

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By following a healthy diet, you can keep your lungs healthy and protect your health for the future. Here are 14 foods for healthy lungs and improved breathing: Water. Garlic and onions.Â The lungs are made of hundreds of thousands of branching tubes that end in tiny air sacs, or alveoli. There are over three hundred million of these tiny sacs in our lungs, offering roughly the surface area of a tennis court to keep up with the respiratory demands of the body. The membranes of these tiny air sacs are also thinner than tissue paper to maximize the exchange of gases. Our lungs make up a large part of our immune system.Â Pure, clean water is essential to keeping blood flowing to and from the lungs. It also keeps our lungs hydrated and the mucus flowing. There are tiny air sacs called alveoli in your lungs. These delicate air sacs transfer oxygen from the air into your blood. At the same time as oxygen is being absorbed into your bloodstream, carbon dioxide is being transferred from your bloodstream into the air sacs.Â When the lungs are exposed to high concentrations of dust, toxic vapours, cigarette smoke, etc.,human filtering mechanisms can become overloaded and damaged. Once they are damaged, various bacteria, viruses, etc. are more likely to grow in the lungs, causing infections such as pneumonia.Â Lungs â€“ Asbestos silica, cotton dust (tdi), cadmium, diesel emissions, bagasse dust, bauxite dust. Gastrointestinal tract â€“ Asbestos, nitrosamines, welding fumes, lead SKIN Acrylis, epoxy resins, nickel, coal tar, benzene. Test your knowledge of lung disease and the importance of clean air with the Healthy Lungs for Life quiz. The quiz is made up of 10 questions, with 1 point for every right answer. Start the quiz. European Respiratory Society European Lung Foundation. In partnership with: Almirral, AstraZeneca, Boehringer Ingelheim, Comprehensive Pneumology Center, Helmholtz Zentrum MÃ¼nchen, Linde, MundiPharma, Munich Loves You, The Menarini Group, Messe Munchen International, Novartis, Pfizer, Sandoz. Healthy Lungs for Life. Clean air and your lungs quiz | Question 1 of 10. Q1 | During hot summer days, when sh