YALE NATIONAL INITIATIVE
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Curriculum Units by Fellows of the National Initiative
2012 Volume VI: Asking Questions in Biology: Discovery versus Knowledge

Inquiring Minds Want to Know...Teaching Vertebrates through Inquiry

Curriculum Unit 12.06.05, published September 2012
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Introduction

In my third grade classroom I ask my students questions and my students ask me questions, yet these questions are increasingly becoming safe, non-committal questions. I want to ask a question that I know I know the answer to, so that I can evaluate my students' answers. If my students even ask a question, they want to ask questions that show they are interested, however that they are not ignorant. My goal is to develop strategies for developing meaningful questions for both my students and myself. I want to reignite the natural, inherent curiosity of my students so they feel free to express their inquisitiveness and realize that the answer is not the goal, as this signifies the end of the journey. The goal is to uncover as much information as possible and still understand there is more to learn. The goal is to help them think like scientists!

The Bee Hummingbird, at 5cm and 2g in weight, is the smallest bird in the world. A woodpecker can peck 20 times in one second. The fastest bird, the spine-tailed swift, can fly as fast as 106 mph. Wow I know a lot about birds! Perhaps I should change professions and become an Ornithologist; slow down there, let's take a deeper look at my understanding here. I know a few quick facts, but does knowing facts equal knowing about birds? Many of my students believe that if they uncover a list of facts they have "learned" everything there is to learn about a subject (I suspect that some teachers may believe this too!).

So what is my goal here? Facts are fascinating and an excellent way to hook my students to get interested in a topic. I want to help my students see that facts are just the beginning; the journey can begin for them right at the point where the facts run out. Why has the Bee hummingbird evolved to be so small? How strong is the woodpecker's beak? Is the spine-tailed swift smaller or lighter than other birds, allowing it to reach such great speeds? Through developing this inherent curiosity that children have, I would like to present them with the steps of the Scientific Method to enhance their questioning. This process is relied upon for experimentation that is used to explore observations and answer questions.

Objective

The FOSS science kit, Human Body, has been selected by my district as a resource for providing science instruction. One of the standards that is emphasized in the teaching manuals is Science as Inquiry. This standard goes on to explain that students are to ask and answer questions and plan and conduct simple experiments. Yet, throughout the investigation the questions students are led to ask are lower-order thinking questions with a clear and expected answer. Further, the students will conduct simple experiments but have very little input to the planning of these activities, as everything is developed for them by the kit. The kit does an excellent job of providing hands-on activities and introducing my students to information about the human body, but I believe it falls short of increasing inquiry skills in my students. Throughout this unit you will receive information on the Scientific Method, developing skills in asking questions, and strategies that will help you advance the critical thinking skills of your students.

I know I will never be able to teach everything there is to know about the form and function of organisms so I need to choose something to hang the idea on and enable my students to place it in context of a bigger picture. Through the introduction of the bones in the human body, we will move into learning about vertebrates and then do a comparative investigation of the form and function of the bones found in different species. Students will look at x-rays and diagrams to investigate the form and work to determine the function of human bones. Next they will dissect owl pellets to uncover the actual bones of rodents. Using graphic organizers, students will sort and classify the bones found in the owl pellet. We will then begin to consider the similarities and the differences between the structures of vertebrates. Later we will dissect albatross boluses. The purpose of this will then be to highlight the differences in the diet of these two birds. As students think about these two birds and the pellets of both, they have a large variety of avenues for research. After developing their questions based on their observations, some students may want to study the habitat of the owl versus the albatross; the physical traits of the two birds or diet differences. The possibilities are diverse.

In an effort to create a cross-curricular unit, students will be expected to complete readings using non-fiction texts and resources from the internet. They then will share their new found knowledge through presentations. Students will be introduced to some of the biologists that have made significant contributions to our understanding of biology. Using the non-fiction resources, students will research a biologist and create a final project. The final project will be self-selected by the students from a variety of choices ranging from Prezi or Power Point presentations to artwork or replicas of the biologist's work. Students will also investigate discoveries in science that were either accidental or later proven to be inaccurate. I am hoping that through these explorations, students will discover that science is a process toward better understanding not just a search for answers.

Demographics

The Red Clay Consolidated School District is located in Northern New Castle County, Delaware with a combination of urban and suburban settings. Some of its elementary schools are located in the heart of the largest city in the state. The district is comprised of 28 schools with approximately 1000 teachers. It services over 16,000 students. Of those students, 27% are African American, 4% are Asian, 20% are Hispanic, and 49%

are White. Students' needs vary, with almost 15% receiving Special Education Services and 10% receiving English Language support. In addition, 41% of the students come from families with low incomes.

Highlands Elementary is an urban school in the city of Wilmington, Delaware. We are a small K-5 school with an enrollment of an average of 320 students. Eighty-six percent of our student make-up is represented by ethnically minority populations while 82% of the students fall into the classification of low socio-economic status. I am a third grade teacher with a class size varying between 24-28 students which are representational of the make-up of the school. Recently I have been designated as an inclusion teacher. I collaborate with Special Education teachers who come in to assist during the English/Language Arts block and during Mathematics instructions. I am the primary teacher responsible for instruction of all, general education and special education, students for all other subjects.

Inquiry

In order to create a classroom full of active learners, I must involve my students in their learning and help lead them to understand. I would like to change my students from passive receptors of information, into active, inquisitive collectors. Inquiry learning is about seeking knowledge through questioning. Anyone who has spent some time with a four-year-old knows that questioning comes naturally, rapidly and without end! Do giants have swimming pools? Why are they called jellyfish, are there peanut butter fish? How many raindrops did it take to fill that puddle? Yet by the time they reach third grade, those questions have been scaled back. Students are afraid to let on that they don't know everything. Firestein asks in his book *Ignorance*, "... what if we understood the power of not knowing in a world dominated by information?" [1]

When looking through the window of an inquiry based classroom, viewers may see some incredible sights. In an inquiry based classroom students see themselves as scientists. They look forward to science and show a curiosity to learn more. They are working with the other scientists in the classroom in order to reach a shared goal that they have a vested interest in because they have decided on the path to take. This path has been built by them as they become active learners and feeds the inherent inquisitiveness they have about the observations they have made. In an inquiry based classroom, the students are designing experiments and posing questions and explanations. Students know that other scientists have come before them and they can use the knowledge these previous scientists have uncovered to fortify their own investigations. Students know that the end of their experiment may or may not answer the questions they began with yet they know that all of the information gathered uncovers some learning. Students in an inquiry classroom become comfortable communicating by using scientific journals. The scientific journals will have pictures, observations, hypotheses, an analysis of the findings, and what the next steps could be.

Inquiry Method

In order to change my classroom to include more inquiry in a scaffolded, structured way, I will be utilizing three forms of inquiry based instruction; structured, guided, and open inquiry. The goal is to get students to make observations and then propose descriptions and justifications of what they observed. Beginning with *structured inquiry* will enable my students to have the process modeled and still feel supported by me. In this model, I will provide my students with hands-on activities, will detail the procedures they should follow, and will supply the materials needed for the investigation. I will not give the students any expectations for the

results. The students may feel unsure of themselves and will constantly check with me to make sure they are "doing it right". This is okay and I will provide support but no answers! As the lessons progress, we will move toward *guided inquiry*. Here the students will be given more freedom over the exploration and will be provided with materials and a question or problem they will need to investigate. The students will be responsible for developing the procedures they will follow. Since students are creating their path, there should be fewer calls for direction, well at least that's the plan! When the students have begun to feel comfortable taking a more active part in the development of a personal learning plan I will move to an *open inquiry* opportunity. During this type of inquiry students will create their own plan for an investigation. This will enable students to explore areas of study that interests them and build a personal connection to science.

Scientific Method

Science is a human endeavor involving knowledge learned through inquiring about the natural world. Scientific claims are evaluated and knowledge changes as a result of using the abilities and understandings of inquiry. The pursuit of scientific knowledge is a continuous process involving diverse people throughout history. The Scientific Method helps to place a framework around a scientist's observations and thoughts. This method is a process that moves the student away from memorization of facts. It enables students to take charge of their learning. There are several steps in the Scientific Method; observation, question, hypothesis, test, analyze, and communicate.

Observation

Scientists make observations. They study things around them. They look at how other scientists have explained things and begin to wonder, what next? The best experiments and research begin with wondering about things that they see and that they are interested in. "I wonder" statements are a terrific way to begin to get students to make observations and move into questioning.

Question

Now students will formulate a question based on what they have observed. When students are thinking of their questions, they need to keep in mind that they will have to uncover evidence that they will be able to measure to answer their question. If they cannot think of a way to test their questions, they will need to fine tune the questions. Students will need to have this skill modeled. They will undoubtedly begin by formulating "yes/no" questions. They should look into what other scientists have already uncovered about their topic. One great thing about science is that we can learn things by looking at what other scientists have discovered and move to the next step. Science builds on what was done before.

Hypothesis

A hypothesis is similar to an educated guess. Most scientists have an idea of what they believe their question will uncover. Some of the greatest discoveries have come by proving the initial hypothesis incorrect. Another great thing about science is even if your hypothesis is wrong, you have learned something!

Test

Scientists now must prove their hypothesis with experiments. First, they design an experiment and create a plan by establishing variables, things within the experiment that you can change or you choose to keep constant. Then they will develop and follow a procedure and determine what materials will be needed. As they

work, scientists keep track of everything that they observe and write these observations down.

Analyze

After the experimentation, scientists need to look at their data and notes on observations. They will need to summarize what they have seen. They must decide what the information means and what will be the next steps to take. Further testing may be necessary or clarification of some data may be needed. The information may even prove that the hypothesis was wrong! Next the scientist will need to explore why this has happened and what information has been learned.

Communicate

Now scientists need to explain what the results show. Scientists need to make sure that they report their findings in a clear, concise way. The entire process should be detailed and described so if someone would like to replicate the experiment they will be able to do so.

Background Information

Vertebrates

The first vertebrates originated around 525 million years ago and are animals that have a backbone with a spinal cord. There are over 85,000 species of vertebrates, yet they only make up 5% of all animal species. Vertebrates can include fish, amphibians, reptiles, birds, primates, rodents, marsupials, and mammals. Vertebrates have bones; these bones may have started as a hard protective outer covering but then evolved into a hard inner framework surrounded by soft tissue. Vertebrates are therefore able to change in size and weight without having to reshape an outer shell. Vertebrates are not the largest organisms in number, however their size and ability to move often leads to their changing or controlling their environment. There are five classes of vertebrates: mammals, birds, amphibians, reptiles, and fish.

Mammals

Mammals have characteristics that help to identify them from other animals. Most mammals have fur or hair covering their bodies. Mammals are warm-blooded animals; which means they can maintain a constant body temperature regardless of their environment. Mammals give birth to fully developed young and the females can produce milk in order to provide nutrition to their young. Most mammals walk on four legs, whereas humans walk upright on two legs. There are mammals that live in water and they have fins or flippers for locomotion. Mammals include humans, primates, marsupials, rodents, seals, whales, and dolphins.

Birds

Birds have three major defining characteristics; feathers, beaks, and wings. Bird's skeletons are adapted for flight; the bones of a bird are very thin or in some cases hollow, making their bodies light. Instead of teeth, birds have beaks that are used to tear apart or capture their prey. Depending on the size of the bird, their diets can include insects to mice and fish. The claws and talons of some birds can lock into place allowing them to perch and to capture prey. The respiratory systems of birds are adapted to make it easier to breathe

air at higher elevations where it is thinner. Birds hatch their offspring from eggs with shells. Birds, like mammals are warm blooded.

Amphibians

Amphibians lay their eggs in water and some resemble fish when they first hatch. Amphibians undergo several changes in their life cycle. Depending on the species or stage in the life cycle, amphibians have the ability to breathe through lungs, their skin, gills, or the lining in their mouths or a combination of these.

Reptiles

Some reptiles have been around for a long time, even during times when dinosaurs roamed the Earth. The most recognized reptiles are alligators, snakes, tortoises, turtles, and lizards. Even though many reptiles live in the water, they are air breathing animals. Most reptiles have bodies that are covered in scales. Reptiles reproduce by laying eggs. Reptiles are cold-blooded animals which cannot regulate their own body temperature. Many will sit on a rock in the sun to get warm or will lay under a rock to stay cool. Snakes are vertebrates that have no limbs and therefore slither using a series of muscles to get around. Lizards have developed a variety of adaptations in order to survive, chameleons can change color to match their environment, and some lizards can shed their tails to escape a predator.

Fish

Most fish breathe through gills which filter the oxygen out of the water. The fish skeleton is made up of bones or cartilage, flexible connecting tissue. Fish with skeletons have an air bladder which allows them to float. Fish made up primarily of cartilage sink and therefore need to move continuously to survive. Most fish move through the water using a dorsal fin. Some fish eat plants found in the water yet some fish eat other fish.

Comparative Anatomy

Humans

The average human adult has 206 bones while a baby is born with approximately 60 more which will fuse together as they grow. The skeleton gives humans their shape and serves also to protect vital organs. The brain is protected by the skull while the rib cage provides protection for the heart and lungs. Muscles connect to bones by tendons which facilitate movement. Bones are connected to each other by ligaments and where they meet a joint is formed. There are several types of joints located throughout the human body which allow the body to move in different ways. A hinge joint joins two moving bones which are connected by strong ligaments. This joint allows the bone to move back and forth in one plane, similar to the opening and closing of a door, examples of a hinge joint include the elbow and the knee. The pivot joint has one bony cylinder and one ring like structure which enables the joint to move in a semi-circle. The bones that connect the first vertebrae to the skull form a pivot joint. The gliding joint has bones that are coated with a fluid-secreting membrane that reduces friction. The bones are generally flat or slightly rounded and move in a wide range of motion, the vertebrae in the spine, fingers, and the wrist bones are examples of gliding joints. The ball and socket joint is my favorite! This joint involves one rounded bone, the ball, and one concave or cup-like bone, the socket, that fit into one another. The joint can move in a complete 360 degree circle. Your hip and

shoulder joints are examples of a ball and socket joint.

Bones are not solid. The outside appears solid but has a few canals throughout it. The inside has a network of bone and a fluid called marrow. This marrow makes red blood cells and fat cells. Bones are made up of protein and minerals. The main protein is collagen, which is also found in cartilage. Cartilage can be found in the tip of your nose or your ear. This is what a bone would feel like without the minerals. The major minerals found in bones are calcium and phosphate. Exercise helps to increase your bone density and strength.

Owls

Owls are found on every continent except Antarctica. They have many adaptations that have evolved over time to make them strong, silent night hunters. They are a winged, flight bird and are carnivores, meaning their diet consists mainly of animal flesh or meat. Owls have feathers that lie flat around its face, facial disk, which allows it to focus the sound toward its ear openings. Their ears are asymmetrically placed on either side of the head, allowing for exact sound perception which they use to pinpoint the slightest rustling of prey. Owls also have unusually soft feathers and a fringe on the leading wing that allow for silent flight, which is beneficial in hunting and catching prey. Most owls are subdued in color which gives them a camouflage effect, allowing them to blend in as they sleep during daylight hours. Owls have sharp, hooked beaks and talons which enable them to tear the flesh off of their prey. They prey on small mammals, birds, reptiles, fish or insects. Most species swallow their prey whole or tear off hunks of flesh with their strong beak. After about six hours, the owls regurgitate the undigested pieces of bones, feathers, or fur as a pellet. It is this owl pellet that we will use to study the owls' diet. This pellet will give us information about the size of the owl and the environment in which it lives. Also, it will provide for us a skeleton of a small mammal, possibly a rodent or other bird. Students will be able to sort and classify the bones of this mammal. Further, students will be able to make comparisons between these bones and the bones of humans they have seen in x-rays and pictures.

How is this owl pellet formed? The owl swallows the prey whole or in large chunks, this includes bones and fur. The food travels to the gizzard where the parts get separated into hard indigestible parts and soft digestible parts. The digestible parts then move through the digestive track of the owl. The indigestible parts form a round pellet and are regurgitated. The contents of the owl pellet are dependent on the diet and location of the owl. Some pellets, the ones I receive in my classroom, contain rodents. Pellets of sea bird may contain fish bones. Some owls eat other birds and in this case there will be feathers and possibly seeds that were a part of the other bird's diet. In some cases you may find other objects such as aluminum foil, rubber bands, or small plastic items.

Albatross

An albatross is one of the largest birds with a wingspan of over 11.5 feet; this is particularly impressive since its length is a little over 3 feet long, including the tail. This bird has long narrow wings with a large head making it easily identifiable. The albatross has a long strong bill which is hooked in order to hold slippery prey, such as squid. An albatross spends its life gliding for hours above the ocean and floats on the ocean's surface. The albatross drinks sea water. They are rarely found on land and head there only to nest and raise their young. They nest in large colonies on the cliffs of rocky islands. The female albatross lays one egg and both the male and female take turns incubating the egg for two to three months. After this time, they care for the albatross chick for five to ten months until it is ready to fly. Some albatrosses can live forty to fifty years.

The albatross lives on a diet of fish, squid, and other crustaceans and skims the top of the ocean or dives for its prey. An albatross has excellent eyesight and sense of smell which makes it well-adapted for detecting

prey, even in the dark. They are known to scavenge another bird's kill and will eat carrion or refuge floating on the ocean surface. Albatrosses will mistake trash floating on the water's surface and have been found to have eaten plastic. Albatross parents will regurgitate these things to their offspring. An albatross chick will regurgitate a bolus when it is ready to fledge, fly away, from its nest. This bolus can be dissected to investigate the albatross' diet and the impact of humans on this water-bird species. Pieces of plastic and other man-made materials can be found in some boluses.

Comparative anatomy

Comparative anatomy looks at the structure of different living things to determine the relationships between them. These investigations have shown that a variety of species have evolved from the same ancestors. If you look at the arm and hand of a human, the front leg of a cat, the flipper of a whale, and the wing of a bat, you will think they look different. But on closer inspection, you will see each has an upper arm, an elbow, a lower arm and five fingers. The size and shape of the bones changes with the species yet the structures are similar. Similar structures such as these are called homologous structures. Scientists feel the best explanation for these similar structures is that the above described mammals are descended from the same ancestor. [2]

Not all scientists are right!

Galen and Vesalius

Galen was a prominent Roman physician c 129-200 and has been regarded by some as one of the most influential writers on medical subjects. He performed dissections on pigs and monkeys since he was not allowed to use humans. Galen used the information he uncovered through these dissections to make conclusions about human anatomy. Galen's contributions dominated medicine for nearly two millennia. Then about 1500 years later another physician named Vesalius (1514-1564) came along and performed dissections on human cadavers. He produced a seven volume text that contained accurate illustrations of internal human anatomy. One of Galen's errors was that he thought the human jaw bone was made up of two bones, like a dog's. Also, the human breast bone is made up three segments, not the seven that Galen thought. He believed the humerus, upper arm bone, was the second longest bone in the body while Vesalius proved that the tibia and fibula located in the lower leg are longer, making the humerus the fourth longest. Vesalius began to notice other inconsistencies and studied Galen's work more closely when he realized that Galen had not performed dissections using humans. He then set out to produce a more accurate understanding and spent four years developing his seven volume text, commonly known as *Fabrica*. This text changed the way physicians looked at the work of others and trusted only observations. Vesalius's investigations led to the development of comparative anatomy. Researchers studied animals to find similarities and differences and gradually began to recognize humans share common traits with other animals. Darwin used this knowledge to help him construct his research on evolution.

The Planet Vulcan

Mathematician Urbain Jean Joseph Le Verrier proposed that there was a planet that existed between the Sun and Mercury. He made this proposition based on the irregular orbit of Mercury that was difficult to explain with existing knowledge. Le Verrier argued that the irregularity had to be caused by another celestial body, like a

small planet. He named this planet Vulcan after the Roman god of fire. Other astronomers ready to become a part of this new discovery claimed to see this new planet, which propagated the inaccuracy. After Le Verrier died in 1877, many notable astronomers began to doubt its existence. When Einstein's theory of relativity helped to explain Mercury's odd orbit, the search for the planet Vulcan was dropped. [3]

Phrenology

Phrenology, in its day, was one of the most popular and well-studied branches of neuroscience! Believers in phrenology thought that certain character traits could be localized to specific parts of the brain. Phrenologists would study the shape and size of a person's head to determine what type of personality based on the lumps and bumps. A map of the brain was produced to show 27 different areas. A person who had a large bump in the area of music would be thought to show expertise in this area. True scientists of this time often scoffed at this belief but it was finally debunked when modern advances showed that personality traits were not traceable to specific areas of the brain. [4]

Spontaneous Generation

Aristotle, a famous Greek philosopher (384Bc-322BC), studied from other prominent Greek philosophers, like Hippolytus. These philosophers believed that life could spontaneously come into being from inanimate matter like mud or slime when it was exposed to sunlight. His ideas were confirmed by his studies of maggots and how they appeared to generate out of dead animal carcasses. This theory persisted for hundreds of years until the scientific method was adopted and tests began. Louis Pasteur proved that maggots would not appear if meat was kept in a sealed container. After the invention of the microscope, it was proven that life was formed by a seed, egg or some other form of reproduction. [5]

All of these examples will help my students to see that the joy of science is in the journey not in the outcome. As technology increases, understanding increases. Yet as understanding increases, the irony becomes that we realize how much we still don't know. What is a cutting edge, fantastic discovery today, may be disproven by a better microscope or different filtering system tomorrow. My message to students is, "Begin anywhere" then we will see where the journey takes you.

Strategies

My third grade classroom has students with a variety of reading levels ranging from first grade levels to fourth grade levels and perhaps beyond. Many of my students come from households in which poverty is a reality and therefore require extra consideration. In a study by Hart and Risley, it was suggested that students from low-income households are exposed to far fewer words than from their working-class or white-collar counterparts. After looking at the data, researchers stated, "Extrapolated out to the age of 4, this shows that children from white-collar families would be exposed to approximately 45 million words, and children in low-income families to only 13 million words—a vocabulary gap of some 32 million words." [6] It is my intention to scaffold vocabulary and comprehension instruction in order to provide an entry point for all learners. Vocabulary instruction is an integral part of student's comprehension. This is especially true in the science content area since many of the words and topics covered are not used in everyday language. I will deliver direct vocabulary instruction to explicitly teach words in this content area. Through pre-reading activities,

word banks, and journaling students will be exposed to scientific words and will be encouraged to use these words not only in their writing, but also during discussions in our classroom. As students learn to think like a scientist, they will speak like one as well.

Connecting to Prior Knowledge

One of the best ways to improve comprehension is to link current information to previously known information or prior knowledge. In order to provide effective instruction, teachers need to assess what the students already know about a given topic and develop a path that the learning will take based on the needs of the students. Teachers have been using a K-W-L chart to help students link background knowledge to the purpose of the lessons and finish with a summary of their learning. This chart asks students to tell what the **KNOW** prior to instruction, then explain what they **WANT** to learn through the unit, and finalizing the unit with a summary of what they have **LEARNED**. Through my years of teaching, I have struggle with asking students what they know about a topic and hearing them present me with false information. I was never sure if I should immediately address this false information or let the true facts come out through the instruction and revisit the inaccuracies at the end. What I have done instead is to just retool this chart. In my classroom we now will be working with a T-I-D chart. As we begin our unit, the "T" portion will be: What do I **THINK** I already know? Then to guide our learning we will complete the "I" portion: What can I do to **INVESTIGATE** this knowledge? Our summary will be completed in the "D" section and will ask the question: What did I **DISCOVER**? By making these changes, facts and inaccuracies will be deemphasized. Students will develop a plan for their learning as they determine what and how to examine the topic. They will analyze their findings and communicate these findings. In a sense this forms allows the students to begin to think like a scientist to build on previous information, formulate a plan, and then communicate the results, which is exactly what this unit is all about! See Appendix B

Vocabulary Instruction

Vocabulary development is an integral part of all content learning. There is an undeniable link between vocabulary understanding and comprehension. As a teacher in the elementary grades, one must realize that direct and implicit instruction of vocabulary is vital and should occur daily in the classroom. A variety of vocabulary activities can aid in highlighting the most important words for content area comprehension. Certain words are needed by students to understand the text that they are engaged in, other words will need to be added to their long-term, working vocabulary. The words that are needed for text comprehension should be taught prior to reading the text, but more than an introductory definition may not be needed. However, there are vocabulary words that are integral to the understanding of the entire unit. Students will need to be exposed to these words through a variety of methods. Using the Frayer Model or similar instructional device will aid in this instruction. The Frayer Model utilizes a framework to provide students with the correct definition, examples and non-examples of the word, and discusses the etymology of the word. Especially in science, it is extremely helpful to discuss root words, prefixes, and suffixes, this will help the students unlock the meaning of similar words and will enable students to make connections within and between concepts.

Student VOC Strategy

This strategy helps students analyze word meanings from context. Create a list of key vocabulary words that are coming up. Have students write the original sentence from where the vocabulary word is found. Next students should make a prediction of what this new vocabulary word means. They should then consult a friend or a reliable resource, such as a dictionary, to determine the meaning of the word. Students will create an original sentence to show the meaning of the word. Finally they should draw a picture that will help them

understand the word and explain it. This is a fantastic way for students to analyze and decode words in a text they don't understand. This is the great strategy for students to tackle the vocabulary in the science content area. See Appendix C

Word Banks

Word Banks are places where students can keep a list of words they have learned so that they can refer to them as needed. I prefer to have students keep their word banks on rings. I use a variety of color coded index cards and assign a specific color to a specific part of speech, such as all nouns are on blue cards. Using the rings enables students to develop alphabetizing skills, parts of speech skills, and is more mobile than a journal. Students should be expected to use the words in their writing and their speaking.

Classroom Activities

Lesson One- Owl Pellet Dissection; Comparative Anatomy

Essential Question- What are the similarities and differences in structure and function between a human skeleton and other vertebrates?

Background Information- Students will have made observations about the role bones have in the movement of the human body. They will have used x-rays and posters to determine the number of bones in the adult human body. Students will have constructed a human body skeleton puzzle using brads to represent joints and will have made connections between the form and the function of bones throughout the human body.

Instruction- At the beginning of this activity, as a class we will complete the T and I section of a T-I-D form. Students will then choose five facts form both sections and write them in their science journal. This helps the students to connect to the information, and is an introductory activity teaching them about taking notes. Using information from the Background section as well as non-fiction books and websites about owls, students will discover information about owls. They will determine the diets of barn owls specifically to prime them for the activity to come.

Activity- Students will be arranged into partners or groups of three. I try to keep it under three so that each student participates actively in the dissection. Each pair will be given an owl pellet and paperclips. They will be instructed to straighten the paperclip to be used as a pick. Rules should be established about the appropriate use of the "tools" we will use during activities. Students will be using a recording sheet to help them sort the bones they find inside the pellet. As students begin to pick apart the owl pellet, they will need to make decisions about what type of bone they are uncovering. They will match the actual bone up with the picture of the bone on the recording sheet. As they analyze the bones, students will begin to formulate a hypothesis as to which bones can be compared to those found in the human body. As part of the assessment, students will justify their hypothesis.

Assessment- Each pair will choose at least two of the bones they uncovered from the owl pellet and make comparisons to a bone located in the human body. Using their science journals, students will be looking for structural similarities between the different species and will formulate a theory as to why these bones are similar, why they are different, and what role the function of the bone plays in its form.

Lesson Two- Albatross Bolus Dissection: Comparison between species

Essential Question- How are organisms of the same kind alike and different from each other?

Background Information- Students will have completed the owl pellet dissection and will have received information about the owls, including their diet and habitat. They will use this prior knowledge as they discover the information about the albatross and begin to compare their findings and analyze why there is a difference in the contents of the pellets.

Instruction- Using information from the Background section as well as non-fiction texts and websites, students will learn about the habitat and diet of the albatross. Students will complete a Venn diagram comparing the information they discover regarding the two birds.

Activity- Students will be arranged into partners or groups of three. Each group will receive an Albatross bolus and paperclips, and complete the dissection following the procedures they followed during the dissection of the owl pellet. Students will use their science journal to make a hypothesis about what they will find as they dissect the bolus. Next, they will separate and sort the contents of the bolus. Upon inspecting the contents of the bolus, students will make observations and a hypothesis about the habitat of the albatross and what impact humans are having on the albatross.

Assessment- Students will make observations in their science journals. They will develop a theory about why the contents of the pellets are different while using their knowledge of the diet and habitat of both birds. As a class, we will complete the D section of the T-I-D form we began at the beginning of this unit.

Lesson Three- Famous Scientist: Students design an investigation

Essential Question- How have past scientific contributions influenced current scientific understanding of the world? What do we mean in science when we say that we stand on the shoulders of giants?

Background Information- As a class we will complete a quick version of the T-I-D form to assess what they may or may not know about scientists and what they do.

Instruction- Using the information in the section Not all Scientists are right! And in Appendix A, I will provide a framework for my students regarding scientists, their advancements through time, and the refinements that come as more information is uncovered and knowledge is broadened.

Activity- Students will work with a partner to research a scientist. They will be able to choose one of the scientists they were introduced to or they may choose one that they have an interest in researching. Using a research template to guide their information discovery, see Appendix D, students will use the internet and non-fiction resources available in the classroom and the library at school to learn about the scientist's background. They will determine what the scientist's contribution was to our lives and understanding of our world. After they have completed their research, they will create a presentation method to deliver their new found information to the class. Some choices could be but not limited to; power point, prezi, play, or poster.

Assessment- Using the steps of the Scientific Method and information they gained through their research of famous scientists, students will design their own investigation. The guidelines will be vague in order to encourage students to make observations of their own world and tap into their own inquisitiveness. The purpose of this assessment is not to have students solve a problem, but to recognize they do not know something and can create an investigation to study this topic.

Standards

Science Standards

Standard 1: Nature and Application of Science and Technology

1.1.A.Understand that: Scientific investigations, whether conducted by students or scientists, involve asking a question about the natural world. Be able to: Generate questions and predictions using observations and exploration about the natural world.

1.1.B.Understand that: In a science investigation, a fair test is one in which all of the conditions are kept constant except the one condition being investigated. Be able to: Generate and follow simple plans using systematic observations to explore questions and predictions.

1.1.C.Understand that: The purpose of accurate observations and data collection is to provide evidence. Scientists use tools to enhance their senses in order to obtain more evidence. Be able to: Collect data using observations, simple tools and equipment. Record data in tables, charts, and bar graphs. Compare data with others to examine and question results.

1.1.D.Understand that: Scientists use observations from investigations and knowledge that is already known to develop an explanation. Be able to: Construct a simple explanation by analyzing observational data. Revise the explanation when given new evidence or information gained from other resources or from further investigation.

1.1.EUnderstand that: The purpose of communicating with others is to share evidence and conclusions. Scientists communicate the results of their investigations to others. Be able to: Share simple plans, data, and explanations with an audience and justify the results using the evidence from the investigation.

1.1.F.Understand that: The use of mathematics, reading, writing, and technology are important in conducting scientific inquiries. Be able to: Use mathematics, reading, writing, and technology when conducting an investigation and communicating the results.

1.3.A. People from all parts of the world practice science and make many important scientific contributions.

1.3.B. Much has been learned about the natural world but there is still much to understand.

Standard 6: Life Processes

6.1.A.Plants and animals are similar to and different from each other in observable structures and behavior. These characteristics distinguish them from each other and from nonliving things.

6.1.B.Each plant or animal has different structures that serve different functions in growth, survival and reproduction.

6.1.C.In animals the skeletal-muscular system provides structure, support and enables movement.

6.2.A.Plants and animals are living things. All living things have basic needs for survival including air, water, food (nutrients), space, shelter, and light.

6.2.B.In addition to basic needs for survival, living things have needs specific to the organism such as temperature range and food requirements.

Common Core English Language Arts Standards

Reading: Informational Text

RI.3.1. Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

RI.3.2. Determine the main idea of a text; recount the key details and explain how they support the main idea.

RI.3.3. Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

RI.3.4. Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

RI.3.5. Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently.

Writing

W.3.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.

Develop the topic with facts, definitions, and details.

W.3.7. Conduct short research projects that build knowledge about a topic.

Appendix A

Famous Biologists

This is a quick list of scientists that impacted the field of biology. This is not meant to be a complete list. It will be used to introduce students to famous scientists and give them a direction for their research projects.

Aristotle (384-322 B.C.) was a Greek philosopher and early scientist and is sometimes referred to as the "father of biology." Aristotle worked to set up an organized framework of knowledge that served as the foundation for much of the science and philosophy of ancient and medieval times, and therefore for science of the present day. He was a tutor to Alexander the Great and with Alexander as his patron, he was able to describe plant and animal specimens received from all parts of the vast Alexandrian empire.

Aristotle wrote about 400 treatises. Some of his works include "Historia Animalium" (Enquiry into Animals), "De motu animalium" (On the Motion of Animals), "De incessu animalium" (On the Gait of Animals), "De partibus animalium" (On the Parts of Animals), and "De generation animalium" (On the Generation of Animals). Much of his information has been proven to be either myth, rumors or

erroneous information. However, this work was used as a starting point for biological studies.

Charles Darwin 1809-1882 developed a theory of how natural selection drives evolutionary change. His book, On the Origin of Species, convinced many of the reality of evolution. Remembered for the theory of natural selection, the credit for which he had to share with Alfred Wallace, who formulated it independently.

Carolus Linnaeus 1707-1778 was a Swedish botanist, zoologist, and a taxonomist. Linnaeus is credited with consistently using a classification system called binomial nomenclature. This system uses two words in a Latin grammatical form. The first word identifies the genus and the second identifies the species within the genus. Humans are *homo sapiens*. The Linnaean system classified living things within a hierarchy, starting with two kingdoms. Kingdoms were divided into classes and they, in turn, into orders, families, genus, and species. His groupings were based upon shared physical characteristics. Although the groupings themselves have been changed since Linnaeus, as well as the principles behind them, he is credited with establishing the idea of a hierarchical structure of classification based upon observable characteristics.

Andreas Vesalius 1514-1564 can be considered the founder of modern anatomy. Vesalius was said to have been born in Brussels near a place where condemned criminals were executed and left to rot, leading one to believe that as a child Vesalius must have been familiar with the details of human anatomy and decaying bodies. As a medical professor, he handled and dissected the bodies himself — this had been the job of underling barber-surgeons up to that time. Though bodies were in short supply, he used every means legal, and sometimes, illegal to get the materials he needed for his studies. Vesalius' drawings were based on direct observation. He transformed his field of research and forever changed the teaching of medicine. Vesalius' famous book titled, "De humani corporis fabric" a (On the Fabric of the Human Body, 1543, 1555), remained the basis of medical illustration for generations and still influences how we look at our bodies today.

Gregor Mendel (1822-1884) was Austrian scientist and monk. Through his experiments with pea plants, he devised an understanding that the inheritance of traits follows particular rules, now known as Mendel's Laws. After his studies with pea plants, Mendel began studying honeybees. He was able to produce hybrid varieties, however could not control the mating of the honeybees and therefore could not successfully define a clear picture of heredity. He has been called the father of genetics.

Louis and Mary Leakey, two of the foremost fossil hunters of the 20th century, are known for their many discoveries relating to early human evolution. Their finds at Olduvai Gorge, a site in northwestern Tanzania, when added to the prior work of Raymond Dart and Robert Broom, convinced most paleoanthropologists that humans originally evolved in Africa. For many years, especially after the discoveries of Homo erectus remains in Java, and in China at Zhoukoudian, the general belief among scientists had been that humans had come into being in Asia.

Appendix B

What do I **THINK** I already know?	What can I do to **INVESTIGATE** this knowledge?	What did I **DISCOVER**?

Appendix C

Student VOC Strategy

Vocabulary Word: _____

1.Write the sentence where the word is found in the text.

2.Based on the sentence, what do you think the word means?

3. Consult an "expert" for the actual definition (friend, text, dictionary).

Expert:

Expert's Definition:

4. Write the word in a sentence of your own.

5. Choose one of the following ways to help you remember the word's meaning: draw a picture; create a movement; connect the word to a story, song, or news report you've heard. Write down how you are going to remember this word.

6. Explain

Appendix D

Scientist Research Guide:

1.Introduction : Briefly describe who the scientist was and what notable thing they did.

2. Personal Information

a. Birthdate and Birthplace

b. Family life

c. Education

d. Occupation(s)

e. Death date and location

3. Include a timeline of the person's life.

4. Accomplishments:

a. What did the person accomplish that makes him/her memorable?

b. What contribution did they make to society?

5. Qualities that made the person interesting

a. What are some qualities that made the person worth reading about?

6. Your Choice

Choose something about your person to write about

7. Bibliography

Use the correct form of bibliography citation for books and other written sources you used. Also, see Bibliographical citation form for web resources.

Resources

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Endnotes

1. (Firestein 2012)
2. (Rene Fester Kratz and Siegfried 2011)
3. (Lists 2012)
4. (Lists 2012)
5. (Lists 2012)
6. (Tankersley 2005)