Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2009 Volume IV: How We Learn about the Brain

How the Heightened Senses of the Sea Turtle, Elephant, and Eagle Are Evident in the Brain

Curriculum Unit 09.04.01
by Nicholas R. Perrone

Objectives

My unit will pose the question, "What is the relationship between form and function in an animal's brain?" Specifically, I believe different species of animals rely more heavily on one particular sense; with each heightened sense, specialized areas of the brain must control them: the female Green Sea Turtle uses magnetism to lay her eggs in the same beach where she hatched; the African Elephant has the amazing ability to create and hear infrasonic sounds too low for humans to hear; and the Bald Eagle uses its acute sense of sight to spot prey from hundreds of feet in the air. Each of these animals has an amazing ability directly caused by a heightened sense. The behaviors of these animals suggest that a major part of their brain must control that sense. Furthermore, if an animal has a heightened sense of smell, I expect that the area of the brain that controls smell, the olfactory lobe, will be larger in size or more developed with respect to the other, less dominant areas. I expect that by the end of the unit, students will be able to answer the initial question. As the authors of The Brains of Animals and Man state, "The kind of brain structure an animal has is related to the kind of life it leads, and to the senses that are most important to its survival." Furthermore, "each sense organ is connected to its own projection area in the brain. In these areas, the electrical energy of nerve impulses is translated into meaningful sights, sounds, smells, tastes, and sensations" (Freedman Morris 1972).

Demographics

The students who will work on this project are predominately African-American urban youth living in the New Haven area. The students come from families of low socio-economic levels and have little interaction with computers. They are in the fourth, fifth, sixth, and seventh grade at the Barnard Environmental Studies Magnet School. Barnard is a school that services approximately 600 Pre-K through eighth grade students. The school's magnet focus is on environmental studies; therefore, it has a strong emphasis on integrated science education.

Since many of the students have little computer experience, this lesson utilizes computers connected to the Internet. The computers will allow the students to access current information on human and animal brain research. This unit reaches objectives from the New Haven Public School's science curriculum.

Author's Perspective

I am a technology teacher who teaches grades K-8. I see most classes every other week and work on interdisciplinary projects with the students. My school is an environmental studies magnet school. This magnet theme encourages me to integrate environmental studies into everything that I teach. Studying about the brains of different animals and how they affect their survival and adaptation is a direct connection to environmental studies. As a technology teacher, I use various computer resources to facilitate student research and design activities. For example, I encourage the students to use both kid-friendly search engines and online encyclopedias to obtain information for projects and classroom assignments. I also use multiple computer programs that allow students to create unique presentation materials; these include slideshow presentations, paper brochures, posters, graphic organizers, and many others. I understand that not all teachers work in such a school or in such a position. It is my goal to connect this unit with regular education classroom teachers who have specific constraints in their classrooms and schools. This integrated unit should complement such settings whether it is used as a whole single project or separate lessons scattered throughout a curriculum.

Strategies

This unit can be directly applied to learning about one animal in a school - a mascot, for instance, or learning about a series of animals. In my school, each grade is assigned a thematic animal that the students learn about throughout the year. My unit will connect with multiple grade levels to facilitate students to learn more about their thematic animal. In particular, it will present information on the animals listed earlier and will match with the following grade levels: 4th (turtle), 5th and 6th (elephant), and 7th (eagle). Each grade level will learn about their respective animal's behaviors, brain anatomy, and its extraordinary senses and then will present this information in the form of a computer slide show, brochure, poster, or concept map. In keeping with 21st Century educational technology modalities, students will be encouraged to also go beyond the basic research and retell method. Students should actively seek experts in the field of animal behavior, neuroscience, and anatomy to further immerse their curiosity in this subject matter. They should also be encouraged to create online blogs where anecdotal information can be shared from students and scientists in the field.

The unit is divided into three different chapters that go into detail about each animal in the study. Each chapter will be structured the same way: 1) example anecdote for student engagement, 2) animal behavior data, 3) animal brain anatomy, 4) tying it all together, and 5) activities that compare human and animal abilities. This structure will provide a framework for educators to reuse this information in the most effective way - in parts or as a whole.

Students will not only research their animal, but they will participate in activities that compare their human brain to that of their animal. Activities will include comparing what they can see at a set distance compared to that of a Bald Eagle. In all cases, students will find the comparisons fascinating since the animal's sense exceeds that of a human. By including the student in the study, each child will engage in deeper discussion and will inquire about the animal to a greater extent. Fictional texts will also be recommended for each animal to complement the information the students learn. In this way, fictional reading will provide another academic area that this unit can develop.

The Sea Turtle: Magnetic Detection & Mapping

1. Anecdote - Long Migration

Teacher: "Imagine wandering from your doorstep here in New Haven, CT and traveling all the way to New Orleans, LA, a total distance of 1387 miles. And after a few months of eating at a series of excellent restaurants, you are told to walk home. Could you find your way?

"A group of green turtles feed off the coast of Brazil where they eat for many months, and every two or three years, swim directly to Ascension Island, 1400 miles away in the middle of the Atlantic Ocean, to lay their eggs" (Maier 1970). The turtles do not have any landmarks to guide them, no GPS navigation systems purchased from the local electronics store, and certainly no road signs; so how do they do it?

2. Animal Behavior Data - From Hatchlings to Adults

After sea turtle hatchlings emerge from their shell, they must dig themselves out from approximately 1 meter of sand and then cross a treacherous beach before they enter the sea. In the sea, these turtles begin to tap into their amazing navigational ability. "[Sea turtle]...hatchlings have a magnetic compass sense, which enables them to maintain headings relative to the Earth's field as they migrate offshore" (Lohmann 2007). As soon as they enter the water, this magnetic compass sense engages and leads them to safe areas to feed. "Several laboratory experiments have demonstrated that loggerhead and leatherback hatchlings can orient to the magnet field of the earth" (Lutz and Musick, 1997).

In addition to simple directional compass readings, "...hatchlings can detect magnetic field inclination angle and magnetic field intensity, two geomagnetic features that vary across the surface of the earth and may provide sea turtles with information on their global position" (Lutz and Musick, 1997). These observations point out just how amazing are their abilities.

The precise readings these animals detect are incredible. And as they get older, they develop even further. "Older juveniles learn the magnetic topography of the area where they live and develop 'magnetic maps' which permit navigation toward specific target areas" (Lohmann 2007). These mental maps provide the markers that enable such feats of navigation as these animals perform.

Specifically, "...loggerheads can distinguish between different magnetic inclination angles and perhaps derive from them an approximation of latitude" (Lutz and Musick, 1997). With these latitude approximations, the magnetic maps become detailed navigational coordinates. Eventually, the turtles use these maps to travel over large distances. "An ability to return to a specific nesting beach [where they themselves emerged as hatchlings] from hundreds or thousands of kilometers away, and after years in distant oceanic or coastal habitats, is common among sea turtles" (Lutz and Musick, 1997).

3. Animal Brain Anatomy - The Presence of Magnetite Crystals

In particular, "...a significant part of a turtle's navigational skill involves magnetoreception - the ability to detect the Earth's magnetic field" (Lohmann 2007). Magnetoreceptors in the sea turtle's brain function similar to magnets and detect minuscule variations in the earth's magnetic field.

In one study, the heads of three hatchling loggerhead turtles were dissected; the author of the article found organic magnetite crystals, a comparable substance found in honey bees and homing pigeons - 10^5 more amounts as compared to an extremely sensitive compass, suggesting their sensitivity can notice slight changes in the earth's magnetic field and intensity (Kirschvink 1980).

An expert on loggerheads, named Jack Rudloe, demonstrated the magnetic properties on an Olive Ridley hatchling that was found dead on a Costa Rican beach. He brought the hatchling to the lab, placed it on a small sponge in a large pan of water, and began pulling it and spinning it around with an ordinary magnet near its head. Placing the magnet at its tail made the hatchling slowly spin around until its head faced the magnet again (Spotila, 2004).

4. Tying It All Together - Life Finds A Way

The magnetite crystals in their brains help sea turtles detect magnetic information like the inclination of the earth's magnetic field, which is the angle the magnetic field intersects at the surface of the earth. The equator has a zero degrees inclination while the poles are 90 degrees. Sea turtles can also detect slight changes in the field's intensity. Using these skills, the turtles can create a virtual magnetic map of the oceans allowing them to navigate precisely toward a particular area - nesting beach, feeding sea, etc. Although, what makes sea turtles amazing is that even if their magnetic sense is disrupted, they use other senses like sight and smell to assist them in migration (Spotila, 2004). A study of a group of green turtles demonstrated that even when their magnetic field was disrupted, the turtles still navigated back to Ascension Island, more than 2,000 km away. Scientists attached six static magnets to each turtle with the purpose of creating artificial fields around them. The trip the turtles made back to Ascension Island was similar to the same trip made by eight turtles the previous year. Magnetic navigation is therefore not the only migratory mechanism turtles rely upon (Papi et al, 2000).

Furthermore, "…when magnetic cues are disrupted, the turtles can fall back on other sources of information such as celestial compasses, wave direction, or olfactory cues, in much the same way that blind and blindfolded people are often able to use non-visual cues to guide themselves" (Lohmann 2007). In other words, as amazing as their ability to read and follow the earth's magnetic field, the truth is that sea turtles do not rely solely upon one sense for survival. Life tends to find a way no matter what.

5. Classroom Activities - Testing Student Navigational Skills

See the lesson plan #1, "Can you navigate as well as a sea turtle?" in the Appendix.

The Elephant: Infrasonic Hearing

1. Anecdote - Disney's Happy Ending

An elephant filmed in the Disney movie, Earth, was able to find her way back to her herd amidst separation of many miles and a fierce sand storm. The Kalahari Desert herd was traveling to a yearly flood area at the inland delta, Okavango, when a storm hit. The elephant was disoriented and dehydrated; she fell back from the herd and began going the wrong direction. Eventually she made her way back to the herd (Fothergill 2009). How did she do it?

2. Animal Behavior Data - From Foot to Ear

An elephant's sense of hearing is remarkable and is in part due to the size of its ears. He can produce infrasonic (very low) sounds allowing communication over long distances. These very low frequencies are not detectable by humans; humans can hear between 29-19,000Hz whereas elephants can hear frequencies as low as 17Hz, but only as high as 12,000Hz (Fowler and Mikota, 2006). Low-frequency sounds travel further distances as compared to higher frequencies; especially since low frequency sounds can travel through the ground like seismic waves in earthquakes (Davies 2008). This is why thumping bass is all that can be heard from a passing car that is playing music loudly; the actual tune cannot be heard since the other sounds are of a higher frequency and do not travel as far.

Elephants are social animals and, therefore, use vocal communication as a part of their society and survival. However, these levels of communication go far beyond the animal's ability to hear through the air. Elephants have the ability to produce low-frequency vocalizations at high amplitudes that actually travel into the ground and along its surface (O'Connell-Rodwell, 2007). They use their foreheads as huge sounding boards and transfer these infrasonic rumbles over large distances allowing distant herds to reunite and lone males to locate females (Downer, 1999). There are vibration sensors in the elephant's trunk, feet, and even toenails that react to vibrations and transmit nerve signals to the brain (Davies 2008). Therefore, it is possible that the Disney happy ending mentioned in the previous section was a result of infrasonic communication through the ground.

3. Animal Brain Anatomy - Massive Brain, Massive Ability

The average weight of an African elephant brain is between 3.6-6.5 Kg (7.9-14 lbs.). It is the largest brain of any land animal. In comparison, the human brain weighs between 1.3-1.4 Kg (2.8-3 lbs.). The elephant has the largest proportion of brain weight to body size of any other animal; even though the blue whale has a larger brain, its brain weight to body weight ratio is much smaller than an elephant (Davies 2008).

Elephants have the largest cerebral cortex of all land animals; this allows the animal to process subtle signals from noise including being able to use multimodal cues available to them, such as listening to the sound vibrations they feel through the ground (O'Connell-Rodwell, 2007). And since these sounds compete with very little other seismic noise, elephants can communicate with ease. A large portion of the elephant's brain is devoted to hearing: the temporal lobe; and it is far greater in proportion size than that of dolphins or humans (Davies 2008).

4. Tying It All Together - Herd Survival & Communication

When elephants are threatened they thump the ground in mock charges. The vibrations from these charges carry upwards to 30 miles through the surface of the ground. Other elephants "hear" them as the vibrations travel through their feet and into their ears. Coupled with the infrasound, these vibrations communicate levels of danger and caution for other herds (Downer, 1999).

The elephant uses these seismic stimuli to avoid or threaten predators, assess and navigate within the environment, and communicate. "This has important ramifications for a herd's ability to maintain contact with other herds, while minimizing conflict over resources, and also the distance over which a warning of danger can be detected from another herd" (O'Connell-Rodwell, 2007). Therefore, an elephant's purpose for effective communication is in part for survival, but also to promote a peaceful balance of resources and interaction.

Furthermore, elephants have an interesting succorant behavior with other elephants. In an observational study, two elephants were found supporting a third elephant that was wounded (Maier 1970). This act of giving support is a clear measure of the elephant's intelligence and compassion, and can be attributed to the animal's large temporal lobes - an area associated with memory and learning (Fowler and Mikota, 2006). It is also important to consider the emotional factor behind this observation. Like humans, elephants have the ability to cry tears from their eyes; this fact is usually appreciated by younger students. Therefore, the fact that these elephants were helping out a wounded friend may be due to their emotional attachment to that member.

5. Classroom Activities - Testing Student Hearing Skills

See the lesson plan #2, "Do you listen like an elephant?" in the Appendix.

The Eagle: Acute Eyesight

1. Anecdote - An Eagle's Unfair Advantage

Imagine you are a salmon swimming peacefully up an Alaskan river. You struggle up waterfalls, dodge the heavy footsteps of grizzly bears, and even manage to slip through the nets set out by local fishermen. Just when you think your worries are over, you are grabbed right out of the water and pulled high up into the air. As you gasp for your last few breaths you wonder where this thing came from; after all, you were looking out for all your predators, right?

Wrong; no matter how alert you are as a fish, you are no match for the keen abilities of one of the most efficient predators around: the eagle.

2. Animal Behavior Data - Seeing is for the Birds

Birds have better vision than all other vertebrates and no bird species compares to that of the eagle. Generally, birds can see two or three times more sharply than humans; in comparison, eagles can see better than eight times that of a human. In comparison to their heads, birds' eyes are so large that they leave little room for the brain or for eye muscles. This explains why birds must turn their entire head and neck to align their field of vision (Early, 2003). Many times birds even have to alter their preferred angle depending on how far away they are from an object. For example, raptors spend more time looking straight at objects closer than 8m away. At 21m, they spend more time looking at it sideways. At distances of 40m or greater, raptors look at the object sideways 80% or more of the time; they do this because of the structure of their eye anatomy. Sideways views provide higher acuity vision for the birds whereas front views provide stereoscopic binocular perception (Tucker, 2000).

Birds also see into the ultraviolet range, allowing them to detect subtle differences in plumage as well as slight movements of small animals that are far away (Early, 2003). For example, an eagle can identify and track a rabbit moving almost a mile away. Therefore, an eagle flying at an altitude of 1000 feet over an open space can spot prey over an area of almost 3 square miles. And when one spots prey, it can follow it continuously from 1000 feet down to 0 feet.

3. Animal Brain Anatomy - Retinas, Cones, and Rods…Oh My!

Birds do not rely on their sense of smell, as a result the "smell" area of the brain, the olfactory lobes, are very small. However, large areas of a bird's brain receive and process visual information (Freedman Morriss 1972). In addition, the visual cortex area of a bird's brain is larger than the other areas.

Humans and eagles share many similarities with their eye anatomy. Both have a cornea, iris, lens, retina, and optic nerve. Although the structure of the eye is similar between human and eagle, three distinct differences are clear: eagles have a different ratio of rods to cones, a deep pit of concentrated cells in their retina, and a greater total number of cells in the retina (Barth, 2001).

Rods and cones are specialized cells in the retina; their relative ratio is important in determining quality of vision in different situations. Rods are sensitive in situations with poor light and are best utilized by nocturnal animals. Cones detect colors and are used primarily during the day with the presence of plenty of light. As compared to humans, eagles have a greater concentration of cones as compared to rods, thus giving them finer vision and a greater ability to focus on objects at a distance. The only trade-off is that eagles have a difficult time seeing in the dark (Barth, 2001).

The retina pit, or fovea, increases the spatial resolution set by the relative size of the eye and thus turns the eye into a telephoto lens, giving the bird the ability to closely zoom in on its prey. The pit also contains a greater amount of cones and a high density of nerves that carry information directly to the brain. Humans do not have this pronounced pit on the retina (Barth, 2001).

The eagle's retina is covered with four to five times as many light-sensitive cells per square millimeter as humans. In this case, quantity definitely matters. The more light-sensitive cells in a retina, the greater the resolve power (Discovery, 2008).

With the presence of these three adaptations, eagles have a resolving power that is 8 times sharper than that of the human; one could say that an average eagle can see 8 times better than an average human. Because of this resolve power, eagles also boast the widest field of vision compared to all other animals; giving them the ability to see danger well before danger sees them.

4. Tying It All Together - My, What Big Eyes You Have

Another reason why eagles have such amazing sight is the size of its eyes, which are enormous in comparison to its skull. Generally speaking, the larger the eyes, the more light is let in, the better the vision (Discovery, 2008). If a human's eye was proportional in size to that of an eagle's eye, it would be approximately twice as large. This means it would require a contact lens four times as large as a normal one - about one inch in diameter. Glasses would cover more than half of a person's face.

To emphasize the clear difference between what a human can see versus an eagle, the following is a prime example. If a human with excellent eyesight can resolve a 1 inch object from 100 feet away, an eagle could resolve the same object from 800 feet away. Taking that same formula for a 12 inch object, the approximate size of an edible salmon, would put an eagle's maximum distance to spot this fish at 9600 feet, or 1.8 miles. This is truly a natural marvel!

5. Classroom Activities - Can You See It?

See the lesson plan #3, "Can you see as well as a bald eagle?" in the Appendix.

Appendix I: Lesson plans

---

1. Sea Turtle: Can you navigate as well as a sea turtle?

Lesson Details

Time/Duration: 45min./1-2 Days
Curriculum Focus: Technology/Science
Topic: Sea turtle migration with magnetism

Lesson Summary

Prior to this lesson, students should learn methods of mapping out a room including drawing paper maps with objects placed in appropriate locations and the use of computer drawing programs to create similar maps.
In this lesson, students will wear blindfolds while partners lead them around a room to feel the placement of furniture to create a mental map. They will then attempt to draw out these mental maps using a computer drawing program. A comparison will later be made about sea turtle's ability to draw mental maps using only their magnetic senses of the earth's magnetic field.

Objectives: "Students Will Be Able To..." (SWBAT)

SWBAT use a computer drawing program to create room layout maps
SWBAT use technology to locate, evaluate and collect information from a variety of sources (adapted from the CT Computer Technology Competency Standards for Students) - the students will use Britannica Encyclopedia Online as well as kid-friendly search engines to research more information about sea turtles and their navigational skills

Materials

Blindfolds/Handkerchiefs (one per student)

Computer with projector
Desktop computer w/ Internet access for each student

Motivation/Engagement

Imagine wandering from your doorstep here in New Haven, CT and traveling all the way to New Orleans, LA, a total distance of 1387 miles. And after a few months of eating at a series of excellent restaurants, you are then told to walk home. Could you find your way?

A certain group of green turtles feed off the coast of Brazil where they eat for many months, and every two or three years, swim directly to Ascension Island, 1400 miles away in the middle of the Atlantic Ocean, to lay their eggs (Maier 1970). The turtles do not have any landmarks to guide them, no GPS navigation systems purchased from the local electronics store, and certainly no road signs; so how do they do it?

Instructional Input/Explanation

Pair each student up with a partner; give each pair a blindfold; have one partner blindfold the other. Instruct the seeing partner to make sure the blindfolded partner is safe at all times.
Have seeing partners lead the blindfolded ones into another room and have them walk them to the furniture pieces and feel them with their hands; OPTIONAL: allow blindfolded participants to navigate their way back to a certain area (carefully). At the end, the seeing partners should walk the blindfolded partners back into the original room.
Take the blindfolds off and have blindfolded partners attempt to draw maps of the room they explored using a computer drawing program with which the students are familiar; seeing partners should log on to http://www.meandmephoto.com/Extras/UWPuzzle/PuzClTurt.html and complete the online sea turtle jigsaw puzzle while their partner works on the map
If time permits, switch the roles and lead blindfolded participants into a different room.
Review the maps drawn and compare them to the actual room layout (this should be prepared by the teacher and should show an accurate representation of the room's layout)
Have students answer the journal question: Who is a better navigator: you or a sea turtle? Explain your answer with details from your research.
Explain that sea turtles use many senses to navigate from one area of the ocean to another, but magnetism is their most important sense. Ask students to search for information on sea turtle migration using a kid-friendly search engine. This information should lead the class to websites that explain how sea turtles use magnetism to create mental maps of their location allowing them to migrate over thousands of miles.

Guided Practice/Exploration

Whole Group

- Discuss sea turtle's amazing ability to navigate and migrate using magnetism
- Debrief various examples of room maps - compare and contrast these examples

Individual/Small Group

- Blindfold activity
- Mapping activity on computers or paper
- Research information on sea turtle navigation

Assessment/Evaluation

- Student room maps printed from computers should showcase their ability to create and manipulate objects using a computer drawing program
- Journal responses on the back of the classroom maps

Closure/Conclusion

- Students will state their most amazing discovery from their research or from class to a person sitting next to them.

Extension/Enhancement

- The students will continue researching sea turtle navigation and its use of magnetism in its brain. The presence of magnetite in a sea turtle's brain will also be covered. A lesson with magnets will help emphasize their conceptual understanding of magnetism.

2. Elephant lesson: Do you listen like an elephant?

Lesson Details

- Grade: 5 th and 6 th
- Time/Duration: 45min./1 Day
- Curriculum Focus: Technology / Science
- Topic: Elephant hearing ability & infrasonic communication

Lesson Summary

- This lesson introduces to the students the idea that sound waves can travel through the ground or objects by vibrations rather than just hearing something through the air. It also points out that some animals can hear sounds outside of what the human ear and brain can detect.

Objectives: "Students Will Be Able To…" (SWBAT)

- SWBAT use technology tools to enhance learning.
- SWBAT use technology to locate, evaluate and collect information from a variety of sources (adapted from the CT Computer Technology Competency Standards for Students) - the students will use Britannica Encyclopedia Online as well as kid-friendly search engines to research more information about elephants and their hearing and communication abilities.

Materials/Preparation

- Desktop computer w/ internet access for each student

Motivation/Engagement

Read the following anecdote: An elephant filmed in the Disney movie, Earth, was able to find her way back to her herd amidst separation of many miles and a fierce sand storm. The Kalahari Desert herd was traveling to a yearly flood area at the inland delta, Okavango, when a storm hit. The elephant was disoriented and dehydrated; she fell back from the herd and began going the wrong direction. Eventually she made her way back to the herd (Fothergill 2009). How did she do it?

- Begin speaking to the students in a low volume so they can hardly hear what you are saying. Ask the students who can hear you to cup the back of their ears to determine if that trick helps to hear your quiet voice. Model cupping the back of your ears so each student can see it.
- Discuss (in a normal volume) what the effect was when the students cupped the back of their ears. Students should respond by saying it allowed them to hear better or it made your talking louder.
- Explain that elephants have an amazing ability to hear over long distances and yet their enormously large ears are only part of the reason why.

Guided Practice/Exploration

- Bring the class to an all metal railing or some other metal object that will allow for proper vibration.
- Have the students place their hands, elbows, or jaws against the railing (whichever each student is able or comfortable doing).
- Instruct a student to lightly tap the railing in different ways: knock lightly, knock heavily, tap it with various materials, hit it with the palm of the hand. The other students should quickly be able to feel the vibrations from the metal railing transfer into their bodies.
- Without talking, have the students return to their computers or a place to write and document what they felt or discovered. This is similar to a journal response; however, it allows the student to express anything they may have felt rather than asking them for something specific.
- Discuss what the students discovered during the activity.
- Have students begin to research elephants and their amazing hearing abilities using kid-friendly search engines and/or online encyclopedias to obtain their information; instruct the students to keep track of their notes on a separate word processing document.

Closure/Conclusion

- Students will share one interesting fact they learned while researching elephants and their hearing abilities.

Extension/Enhancement

- Play some music with heavy bass loudly in the classroom and make sure the door is shut. Before students enter, ask them if they hear the low thumping sounds? Ask the students to determine if there is any difference between what they heard in the hallway as compared to what they heard in the room. Low sounds should travel farther and be the only sounds coming out of the room - this can be compared to the sounds that an elephant makes and how its low infrasonic noises can be heard much farther than a higher-pitched sound.

3. Eagle lesson: Can you see as well as a Bald Eagle?

Lesson Details

- °¤ Grade: 7
- °¤ Time/Duration: 45min./1 Day
- °¤ Curriculum Focus: Technology / Science
- °¤ Topic: Bald Eagle eye sight & resolving power

Lesson Summary

- °¤ Prior to this lesson, students would have learned about the physical structure of the eagle eye in comparison to the human eye.

Objectives: "Students Will Be Able To..." (SWBAT)

- °¤ SWBAT use technology tools to enhance learning
- °¤ SWBAT use a spreadsheet or online graphing program to analyze student data

Materials/Preparation

- °¤ Eye chart website (similar to one from a doctor's office; search "eye chart" in a search engine website)
- °¤ Measuring tape, step meter, or meter stick
- °¤ Desktop computer w/ desktop publishing program for each student
- °¤ Sign with four different sized objects or words in each of the four corners of the paper (the paper should be sectioned off into four equal areas); pictures on paper should be different lengths from 1 to 4 inches
- °¤ Blank papers (one for each student) folded into four equal sections - students will use these to identify what they see from a distance
- °¤ Measure out (or have a small student team do this) a series of short lines or markers extending every 10 feet from a wall or fence until approximately 100 feet has been covered

Motivation/Engagement

Read the following anecdote: Imagine you are a salmon swimming peacefully up an Alaskan river. You struggle up waterfalls, dodge the heavy footsteps of grizzly bears, and even manage to slip through the nets set out by local fishermen. Just when you think your worries are over, you are grabbed right out of the water and pulled high up into the air. As you gasp for your last few breaths you wonder where this thing came from; after all, you were looking out for all your predators, right?

Wrong; no matter how alert you are as a fish, you are no match for the keen abilities of one of the most efficient predators around: the eagle.

- °¤ Hold up the eye exam chart and ask for a volunteer to do a mock-exam: cover up one eye, read as many letters as possible.
- °¤ Post the eye chart webpage you located and allow them to navigate to it. Have student pairs stand away from the computer screens to do vision tests.
- °¤ Ask, "What if you were an eagle, how would your eyesight allow you to see differently?"

Instructional Input/Explanation

- °¤ Begin first journal activity by opening up a word processing program and typing out the answer
- °¤ Model how to log onto Britannica Online Encyclopedia; give students time to remind each other about eagles and their amazing ability of sight

Guided Practice/Exploration

- °¤ Take the class outside, far away from the posted sign
- °¤ Instruct the students to begin walking toward the sign until they know they can identify one or more areas on the sign - this is called their resolving power, the first point at which one can identify an object visually. When students stop, they should draw what they see, write what they read, and note the approximate distance from the poster where they identified the area.
- °¤ Circle up the class to review distances students were to identify the various pictures and words. Using a computer spreadsheet program, have students input the distances into their computers. Graph out the various distances for each object to see graphically which object was easier or more difficult to see.
- °¤ Explain how far an eagle could have been from the same poster to identify the objects (to calculate: multiply the average distance from the class by 8 since eagles can see approximately 8 times as far). Time permitting, graph the eagle results of the same information and compare with the student results.
- °¤ Conduct a class discussion about the eagle's amazing ability to see

Closure/Conclusion

- °¤ Students will state one thing they would do with eyesight as strong as an eagle's.

Extension/Enhancement

- °¤ The next lesson could allow students to determine which eye is their dominant eye and go into detail about peripheral vision.

Appendix II: Implementing District Standards

Connecticut Education Standards

Technology

- °¤ Use a variety of media and technology resources for directed and independent learning activities
- °¤ Use technology resources for problem solving, communication, and illustration of thoughts, ideas, and stories
- °¤ Use appropriate software to organize and present ideas

Science

- °¤ 3.2. Organisms can survive and reproduce only in environments that meet their basic needs.
- °¤ 3.2.a. Plants and animals have structures and behaviors that help them survive in different environments
- °¤ 4.2. All organisms depend on the living and nonliving features of the environment for survival.
- °¤ 4.2.a. When the environment changes, some organisms survive and reproduce, and others die or move to new locations.
- °¤ 5.1.a. Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects.
- °¤ 5.2.a. The sense organs perceive stimuli from the environment and send signals to the brain through the nervous system.

Suggested Reading List

Sea Turtle: Davies, N., & Chapman, J. (2001). One tiny turtle. Somerville, MA: Candlewick Press. This is a children's book that tells the remarkable story of a sea turtle's migration from hatching beach to feeding ground back to the same original beach.

Elephant: Pulley-Sayre, A. (2002). Secrets of sound: Studying the calls of whales, elephants, and birds. Singapore: Houghton Mifflin. The section on elephants is quite informative for upper-elementary or middle school students.

Eagle: Shapiro, P. (2008, January 2). Ellen the Eagle Needs Glasses. Retrieved July 21, 2009, from PublicLiterature.org Web site: http://publicliterature.org/2008/01/02/ellen-the-eagle-needs-glasses/ This online story is great for adding a technology element to a literacy lesson and is for upper-elementary or middle school students.

References

Barth, F. G., & Schmid, A. (Eds.). (2001). Ecology of sensing. Berlin: Springer. This is a great book about the structure of an avian eye.

Davies, G. (2008). Spirit of the elephant: Majestic giant of the animal kingdom. Bath, UK: Parragon Books Ltd. This book goes into great detail about elephants; it includes some spectacular pictures.

Discovery Communications LLC, (2008). Corwin's quest: Episode guide: The eagle's view. Retrieved May 26, 2009, from Animal Planet Web site: http://animal.discovery.com/fansites/jeffcorwin/episode/episode04_09/animals_04.html Jeff Corwin's antics make this a fun video segment about comparing eagle eye retinas to human retinas.

Downer, J. (1999). Supernature: The unseen powers of animals. New York, NY: Sterling Publishing Co., Inc. As a topic, the supernatural abilities of animals could be its own unit; however, this book features a section about the elephant's ability to hear over long distances.

Early, M. (2003). Vision in birds, butterflies, cats, and dogs. Retrieved May 25, 2009, from Sewanee: The University of the South Web site: http://www.sewanee.edu/chem/Chem&Art/Detail_Pages/ColorProjects_2003/Early/ This Webpage compares vision in various animals and features birds since their vision is strong.

Fothergill, A. and Linfield, M. (Director). (2009). Earth [Feature film]. USA: Disneynature. This feature film follows the lives of three sets of animal families; one of which is a herd of elephants that demonstrates the importance of communication in the herd.

Fowler, M. E., & Mikota, S. K. (2006). Biology, medicine, and surgery of elephants.Victoria, Australia: Blackwell Publishing. This book is quite technical, but it goes into great detail about the anatomy of the elephant especially how its body helps detect infrasonic sounds.

Freedman, R, & Morriss, J. E. (1972). The brains of animals and man. New York, NY: Holiday House, Inc. This very amusing book from the early nineteen-seventies, anecdotally compares man's brain to that of the animal.

Kirschvink, J. (1980). Magnetic material in turtles: A preliminary report and a request. Marine Turtle Newsletter. 15, 7-9. This article mentions a sea turtle hatchling dissection - it is the only article of its kind that I came across.

Lohmann, K. J. (2007). Sea turtles: Navigating with magnetism. Current Biology. 17, R102-R104. This is a very informative article that helps explain how a sea turtle navigates on Earth.

Lohmann, K. J., & Lohmann, C. M. F. (1994). Detection of magnetic inclination angle by sea turtles: A possible mechanism for determining latitude. Journal of Experimental Biology. 194, 23-32. This article explains how a sea turtle makes a virtual map in its head to navigate in the ocean.

Lutz, P, & Musick, J. (1997). The biology of sea turtles. Boca Raton: CRC Press. This book details sea turtles from inside out; it relates directly to the study of sea turtle navigation.

Maier, R. A. (1970). Comparative animal behavior. Belmont, CA: Brooks/Cole Publishing Company. This older book introduces the amazing ability of a sea turtle to correctly navigate thousands of miles.

O'Connell-Rodwell, C. E. (2007). Keeping an "ear" to the ground: Seismic communication in elephants. Physiology. 22, 287-294. This journal article sheds light on how elephants communicate from herd to herd in the wild.

Papi, F., Luschi, P., Akesson, S., Capogrossi, S., & Hays, G. C. (2000). Open-sea migration of magnetically disturbed sea turtles. The Journal of Experimental Biology. 203, 3435-3443. Here is another article that adds to the argument about how sea turtles coordinate their internal mapping abilities using the earth's magnetic field.

Spotila, J. R. (2004). Sea turtles. Baltimore: The Johns Hopkins University Press. This book has great pictures of sea turtles as well as detailed information helping to prove how they use magnetism.

Tucker, V. A. (2000). The deep fovea, sideways vision and spiral flight paths in raptors. The Journal of Experimental Biology. 203, 3745-3754. Here is another article on avian eyes; this one focuses on the eye abilities of the raptor.