Grade 4 Model Science Unit 4: How Organisms Process Information (date 2.22.16) **Instructional Days: 10**

Unit Summary
How do animals use their perceptions and memories to make decisions?
In this unit of study, students are expected to develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, they describe that an object can be seen when light reflected from its surface enters the eye. The crosscutting concepts of *cause and effect, systems and system models,* and *structure and function* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *developing and using models*. Students are expected to use these practices to demonstrate understanding of the core ideas.
This unit is based on 4-LS1-2 and 4-PS4-2.
Student Learning Objectives
Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. *[Clarification Statement: Emphasis is on systems of information transfer.]* [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.*]* **(4-LS1-2)**
Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. *[*Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.*]* **(4-LS4-2)**

Quick Links		

Unit Sequence	
Part A: *How do animals receive and process different types of information from their environment in order to respond appropriately?*	
Concepts	**Formative Assessment**
• A system can be described in terms of its components and its interactions. • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. • Animals are able to use their perceptions and memories to guide their actions.	*Students who understand the concepts are able to:* • Describe a system in terms of its components and their interactions. • Use a model to test interactions concerning the functioning of a natural system. • Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. ✓ Emphasis is on systems of information transfer. ✓ *Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.*

Unit Sequence	
Part B: *What happens when light from an object enters the eye?*	
Concepts	**Formative Assessment**
• Cause-and-effect relationships are routinely identified. • An object can be seen when light reflected from its surface enters the eyes.	*Students who understand the concepts are able to:* • Identify cause-and-effect relationships. • Develop a model to describe phenomena. • Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. *(Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works).*

What It Looks Like in the Classroom

In this unit of study, students use the concept of *systems* to understand that every animal has internal and external structures that allow it to take in information from the environment in which it lives, process that information, and respond in ways that increase its chances to grow, reproduce, and survive.

The way in which an organism gathers information will depend on the organism and the body structures that pick up signals from the environment. Many animals, like humans, have sense organs that gather information from the environment through seeing, hearing, feeling, smelling, and tasting. Some animals have sensory receptors or other mechanisms that allow them to sense such things as light, temperature, moisture, and movement. Students need to understand that all animals pick up information from their environment through senses or sensory receptors. In many animals, nerves or neurons then transfer that information to a centralized place (the brain) where it is processed; then, through reflex reactions or learned behaviors, the organism responds in ways that will help it survive and reproduce. In addition, animals often store this information in their brains as memories and use these memories to guide future actions. As students observe animals, either through direct observation or using text and digital resources, they should use models, such as drawings, diagrams, and pictures, to describe the ways that animals (and humans) receive, process, store, and respond to information from the environment in order to survive, grow, and reproduce.

To continue the progression of learning, fourth graders focus on the sense of sight, using models to understand and describe that light reflects from objects and enters the eye, allowing objects to be seen. In first grade, students learned that objects can be seen only when illuminated, and they determined the effect of placing different materials in the path of a beam of light. In this unit, students need opportunities to develop a conceptual understanding of the role that light plays in allowing us to see objects. Using a model can help with this process, which might include the following steps:

- ✓ To review prior learning, ask students to describe what happens to our ability to see objects in a room with no light, and what happens when different types of materials are placed in the path of a beam of light. (If necessary, demonstrate using flashlights and a variety of transparent, translucent, and opaque materials).
- ✓ Using penlights, a variety of lenses, mirrors, and pieces of cardboard, allow students to explore the behavior of light when it comes into contact with these objects. Have students draw and describe what they observe.
- ✓ Using a cardboard shoebox with a 1-cm. slit at one end, shine a flashlight into the box through the slit, and ask students to describe what they see. Place a clear plastic cup of water in the path of the light, and ask students to describe what they observe.
    - o Students should first observe that light travels in a straight line. Lenses and water allow the light to pass through; however, the beam of light is refracted (bent). Mirrors do not allow the light to pass through, but do reflect light, sending the beam in a different direction. The cardboard does not allow any light to pass through, and the beam of light is no longer visible in the same way.
- ✓ Next have students observe a large object, such as a book. Ask them to describe what they see. Place a sheet of transparency film or clear plastic wrap in front of the book, and ask students to again describe what they see. Ask, "How are you able to see the book even though I have placed something in between you and the object?"
    - o Take away the clear plastic wrap and place a sheet of dark construction paper in front of the book, and ask student to describe what they see. Ask, "Why are you no longer able to see the book?"
- ✓ To help students as they try to understand the role that light plays in allowing us to see objects, tell them that they will be using a model that demonstrates how we see objects.
- ✓ Have students use pinhole viewers. (If possible, make these ahead of time. You can find a variety of models and types that are easy to build on the Internet. YouTube has a number of videos that show pinhole viewers made from a variety of materials such as a Pringles tube or black poster board.) Show students

how the pinhole viewers are constructed and what is inside each. Then have students go outside and view objects using the pinhole viewers. As students make observations, they should document what they observed.

- As a class, discuss what students observed, then draw a model on the board that depicts the phenomenon. (Light bounces off of an object, travels through the pinhole, and is visible—upside down—on the tracing paper inside the pinhole viewer.)
- Tell students that this is what happens with our eyes. Light bounces off objects, similar to the way in which it bounces off a mirror, and that light travels into the eye, enabling us to see the objects. We could see the book through the clear plastic wrap because the light that bounces off the object is able to travel through the transparent material and still reach our eyes. We could not see the book through the dark construction paper because the light that was bouncing off the object could not travel through the paper, so our eyes did not receive that light. Therefore, we did not see the book.
- With guidance, as needed, have students draw models/diagrams of the pinhole viewer and the human eye, and have them describe what they observed.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts

Students should use text and online media resources when appropriate to help them understand how animals receive and process information they receive from the environment, and to develop a conceptual understanding of what happens when light reflects off objects and enters the eye. They should also use visual displays to enhance their observations and explanations of the concepts in this unit of study.

Mathematics

Students should model with mathematics as they draw points, lines, line segments, and angles to describe how light behaves when coming into contact with lenses, mirrors, and other objects. Students will also use points, lines, and angles when drawing pictures and diagrams that show how light reflects off objects and into the pinhole viewer or into the human eye.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their

understandings.

- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Research on Student Learning
N/A

Prior Learning
Grade 1 Unit 4: Light and Sound • Objects can be seen if light is available to illuminate them or if they give off their own light. • Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam.

Future Learning
Grade 7 Unit 4: Structure and Function • All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). • Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. **Grade 7 Unit 5: Body Systems** • In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. • Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **Grade 8 Unit 7: Electromagnetic Radiation** • When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the

light.

- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.

Connections to Other Units

Grade 4 Unit 5: Transfer of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- Light also transfers energy from place to place.

Grade 4 Unit 6: Force and Motion

- The faster a given object is moving, the more energy it possesses.

Grade 4 Unit 7: Using Energy Design with Force and Motion

- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.
- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (*secondary*).

Sample of Open Education Resources
Pinhole Cameras and Eyes: In this activity, students make a pinhole camera and see images formed on an internal screen. They then use a lens to see how this affects the images. Students investigate variables in its construction, and explore how it models the human eye's ability to receive and process information. The Life of Environments This unit is designed to address the concept that organisms sense the environment in order to live. It is a far-ranging and comprehensive unit that is designed to address multiple NGSS performance expectations (4-LS1-2, 4LS1-2, 4-PS3-2, 4-PS4-2) in seven explorative sections, with an additional summative assessment step. Time to Think? This resource allows the user to accurately measure and experiment with human reaction time. An interactive program measures reaction times in milliseconds and compares them in different cases (from simply reacting to a visual cue to having to read and then make a decision before reacting). This site provides a wide range of information and activities on the connection between the brain and behavior. Note: Link is to main introductory page. Scroll down to find links for the activity and others pages that allow users to view the results of other participants and guidance for conducting further research. Catch It! This lesson sequence involves student investigation of human reaction time and variables that may affect it. An intitial phase has students practice catching a dropped ruler and converting the distance it drops to the length of time it took to react. This provides an opportunity for data collection, graphing, and writing a conclusion. After this guided inquiry phase, students may conduct research on human senses and reaction time, or move on to designing their own investigations of the effects of variables of their choosing on their reaction times. *[NOTE - the link is to the CT Department of Education Science Curriculum page. Scroll to find that you can select Word, PDF, and Spanish versions of this resource under the title Grade 5 Embedded Task.]*

Teacher Professional Learning Resources
Teaching *NGSS* in K-5: Making Meaning through Discourse The presenters were Carla Zembal-Saul, (Penn State University), Mary Starr, (Michigan Mathematics and Science Centers Network), and Kathy Renfrew (Vermont Agency of Education). After a brief introduction about the Next Generation Science Standards (*NGSS*), Zembal-Saul, Starr, and Renfrew gave context to the *NGSS* specifically for K-5 teachers, discussing three-dimensional learning, performance expectations, and background information on the *NGSS* framework for K-5. The presenters also gave a number of examples and tips on how to approach *NGSS* with students, and took participants' questions. The web seminar ended with the presentation of a number of recommended NSTA resources for participants to explore. View the resource collection. Continue discussing this topic in the community forums. **Evaluating Resources for *NGSS*: The EQuIP Rubric** The presenters were Brian J. Reiser, Professor of Learning Sciences in the School of Education and Social Policy at Northwestern University, and Joe Krajcik, Director of the CREATE for STEM Institute. After a brief overview of the *NGSS,* Brian Reiser, Professor of Learning Sciences, School of Education at Northwestern University and Joe Krajcik, Director of CREATE for STEM Institute of Michigan State University introduced the Educators Evaluating Quality Instructional Products (EQuIP) Rubric. The web seminar focused on how explaining how the EQuIP rubric can be used to evaluate curriculum materials, including individual lessons, to determine alignment of the lesson and/or materials with the NGSS. Three-dimensional learning was defined, highlighted and discussed in relation to the rubric and the NGSS. An emphasis was placed on how to achieve the conceptual shifts expectations of NGSS and three-dimensional learning using the rubric as a guide. Links to the lesson plans presented and hard copies of materials discussed, including the EQuIP rubric, were provided to participants. The web seminar concluded with an overview of NSTA resources on the NGSS available to teachers by Ted, and a Q & A with Brian Reiser and Joe Krajcik. View the resource collection. Continue discussing this topic in the community forums ***NGSS* Crosscutting Concepts: Systems and System Models** The presenter was Ramon Lopez from the University of Texas at Arlington. Dr. Lopez began the presentation by discussing the importance of systems and system models as a crosscutting concept. He talked about the key features of a system: boundaries, components, and flows and interactions. Dr. Lopez also described different types of system models, including conceptual, mathematical, physical, and computational models. Participants discussed their current classroom applications of systems and system models and brainstormed ways to address challenges associated with teaching this crosscutting concept. ***NGSS* Core Ideas: From Molecules to Organisms: Structures and Processes** The presenters were Aaron Rogat of Educational Testing Service (ETS) and Barbara Hug of the University of Illinois at Urbana-Champaign. The program featured strategies for teaching about life science concepts that answer questions such as "How do the structures of organisms enable life's functions?" and "How do organisms grow and develop?" Dr. Hug began the presentation by discussing the arrangement of life science core ideas within *NGSS* and comparing them to previous standards. Next, Dr. Rogat

shared an example of a learning progression, showing how a concept can be taught from early elementary through high school. The presenters then talked about strategies for instruction and shared links to resources.

Visit the resource collection.

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NGSS Core Ideas: Energy

The presenter was Jeff Nordine of the San Antonio Children's Museum. Ramon Lopez from the University of Texas at Arlington provided supporting remarks. The program featured strategies for teaching about physical science concepts that answer questions such as "How is energy transferred between objects or systems?" and "What is meant by conservation of energy?"

Dr. Nordine began the presentation by talking about the role of disciplinary core ideas within *NGSS* and the importance of energy as a core idea as well as a crosscutting concept. He then shared physicist Richard Feynman's definition of energy and related it to strategies for teaching about energy. Dr. Nordine talked about the elements of the energy core idea and discussed common student preconceptions.

Visit the resource collection.

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Appendix A: NGSS and Foundations for the Unit
Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. *[Clarification Statement: Emphasis is on systems of information transfer.]* [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.*]* **(4-LS1-2)**
Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. *[*Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.*]* **(4-LS4-2)**
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Use a model to test interactions concerning the functioning of a natural system. (4-LS1-2) • Develop a model to describe phenomena. (4-PS4-2)	**LS1.D: Information Processing** • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2) **PS4.B: Electromagnetic Radiation** • An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)	**Systems and System Models** • A system can be described in terms of its components and their interactions. (4-LS1-1),(4-LS1-2) **Cause and Effect** • Cause and effect relationships are routinely identified. (4-PS4-2)

English Language Arts	Mathematics
Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-LS1-2),(4-LS4-2) **SL.4.5**	Model with mathematics. (4-PS4-2) **MP.4** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-PS4-2) **4.G.A.1**