Tulsa Regional
STEM Alliance

NEXT GENERATION
SCIENCE
STANDARDS
OKLAHOMA

Science and Engineering Practices
Disciplinary Core Ideas
Cross Cutting Concepts

TULSA COUNTY
PARKS DEPARTMENT

OUTDOOR CLASSROOM TULSA
CURIOSITY • HANDS-ON • LIFE SKILLS

STEM^3 Nature-Based Professional Learning Institute

WHY STEM³, WHY NATURE, WHY NOW

Across classrooms and out-of-school learning environments, educators are navigating rising student disengagement, challenges with executive function, and increasing pressure to integrate new technologies such as artificial intelligence. At the same time, educators themselves report fatigue and reduced instructional flexibility.

Research consistently shows that nature-based, phenomenon-driven learning strengthens attention, self-regulation, systems thinking, and sense making. When learning is anchored in real-world phenomena, students are better able to reason with evidence, communicate ideas, and transfer understanding beyond a single lesson.

STEM³ positions nature as both context and co-teacher. Through the Gather–Reason–Communicate framework, educators experience how rigorous academic standards can be met while simultaneously supporting curiosity, equity, and future-ready skills. This institute is designed to let nature "teach to the test" while restoring joy, relevance, and professional agency to teaching.

Outdoor Classroom - Tulsa
P.O. Box 52826
Tulsa, OK 74152

918.671.1871 Call/Text
brian.b@octulsa.org
www.OutdoorClassroom.org

Tulsa County Parks & Recreation
Chandler Park -
Woodhouse Nature Center
6500 W. 21st St.
Tulsa, OK 74107

918.591.6053
www.TulsaCounty.org/parks

Tulsa Regional STEM Alliance
5005 S. Darlington Ave.
Tulsa, OK 74135

918.779.4910
www.TulsaSTEM.org

Blue Thumb Oklahoma
128 E. 3rd Ave.
Bristow, OK 74010

918.398.1804
www.BlueThumbOK.com

PERSONAL BIOS

BRIAN BOVAIRD
brian.b@octulsa.org

Executive Director and Naturalist

Brian Bovaird graduated with a degree in Geology from Southern Methodist University in 1984, and earned a MBA from Duke University in 1990. For the past eight years, Mr. Bovaird has provided remediation services for hydrocarbon and brine-impacted soils throughout the energy industry.

Mr. Bovaird has studied and participated in well-regarded outdoor education programs in Texas, North Carolina, Vermont, and Colorado. Brian devised today's Outdoor Classroom in 2015 at Camp Loughridge. The program stabilized at the well-manicured Woodward Park before returning to the woods of Mohawk Park in 2024.

AMANDA FISHER
amanda.f@octulsa.org

Lead Naturalist Educator

Amanda graduated from the University of Oklahoma in 2021 with a B.S. in Secondary Science Education, specializing in Chemistry, with a minor in Native American Studies. She discovered her passion for helping students have positive, engaging experiences with science and joined the Outdoor Classroom nearly four years ago. Amanda loves combining her background in science and learning pedagogy to create hands-on, phenomenon-based experiences in nature. Her goal is to show students that STEM is fun, meaningful, and for everyone.

ZOE HALE
zoe.h@octulsa.org

Lead Naturalist Educator

Zoe Hale began working with the Outdoor Classroom program in 2021. She grew up surrounded by the natural spaces of Tulsa Parks, inspired by her mom, who worked her way up to become Head of Horticulture for the City of Tulsa and oversees the city's park system.

Zoe is currently pursuing a Bachelor of Science in Education in Early Childhood Education at Northeastern State University. She is passionate about supporting young learners, especially underserved students, and hopes to continue blending environmental education with early childhood teaching in her future classroom.

CHERYL CHEADLE
Cheryl.Cheadle@Conservation.ok.gov

Volunteer Coordinator

Cheryl Cheadle is the volunteer coordinator for the Oklahoma Conservation Commission's Blue Thumb Water Quality Education Program. Cheryl has spent over 30 years working in water quality education. She has a BS degree from Oklahoma State University in Wildlife Conservation. One of Cheryl's favorite things is working with adults and children in outdoor activities that guide them to become stewards of the earth.

PERSONAL BIOS CONT'

KIM WATSON M.A., C.I.G.

kwatson@tulsacounty.org

Activity Coordinator/Naturalist for Chandler Park

Kim has earned a dual discipline Master's degree in Education and Environmental Studies with a specific focus on Environmental Education. Kim has spent the last 23 years combining her passion of nature and education into a rewarding career in both the formal and non-formal areas encouraging and shaping minds to love themselves, others, and nature!! With a vision of Stewardship, Kim brings passion, compassion, and kindness to her curriculum development, educator workshops, and conservation programming and events! Kim uses the unusual to engage with her students and lets curiosity and inquiry guide her lessons and students' imaginations!

PATRICK T. HAYES, C.I.G.

phayes@tulsacounty.org

Tulsa County Parks Naturalist

Patrick Hayes is the Naturalist for Tulsa County Parks, serving in this role for three years. With a 14-year background in the non-profit sector teaching environmental education and providing direct services he now works within the Samuel Washington Woodhouse Nature Center at Chandler Park. Patrick spends his time teaching homeschool Science, hosting STEM and environmental activities, educator workshops, events, and consults with area schools, universities, regional partners, and national conservation organizations.

In 2023, he earned the Certified Interpretive Guide title through the National Association for Interpreters. He currently serves on the Board of Directors for Tulsa Urban Wilderness Coalition as their Membership Coordinator and in 2025, was selected as the Leave No Trace State Advocate for Oklahoma. Patrick is a restoration ecologist at heart and spends time in Nature studying the interactions of native plants and anthropogenic impact, taking long walks, reading and writing on the topic.

MICHELLE RAHN

michelle.rahn@tulsastem.org

Program Manager

Professional Development | Curriculum & Resources

Michelle is a seasoned educator with a passion for STEM education and space exploration. She has taught for 16 years and has integrated STEM into her project-based instruction. Michelle is a recipient of several awards, including the Presidential Award for Excellence in Mathematics and Science Teaching, the Siegfried Excellence in STEM Education Award, and the Oklahoma Foundation for Excellence in Elementary Teaching. She holds a master's degree in mathematics and science education and is committed to providing equitable STEM education for all students.

MELISSA COBB

melissa.cobb@tulsastem.org

Senior Program Manager

Melissa received her B.S. in Secondary Science Education and M.S. in Curriculum and Instruction from Oklahoma State University. She has 9 years of experience teaching high school Environmental Science, Marine Science, and STEM. Before becoming an educator, she worked as a Medical Laboratory Technologist. Melissa is passionate about supporting teachers and helping students overcome barriers, making STEM education more accessible to all. Melissa enjoys traveling, reading, and training her dogs in competition agility.

SCHEDULE

Day One

8:30-9:00	Arrival, Registration & Welcome
9:00-10:30	Gather-Reason-Communicate (GRC) Framework Introduction
10:30 - 10:40	Break & Transition into Four Learning Groups
10:40 - 11:40	Activity Rotation One
11:40 - 12:10	Lunch (Provided by TRSA)
12:10 - 1:10	Activity Rotation Two
1:10 - 2:10	Activity Rotation Three
2:10 - 3:10	Activity Rotation Four
3:10 - 3:15	Break & Reconvene
3:15 - 3:35	Day Two Preview & Expectations
3:35 - 4:00	Q&A & Closing Reflection

Day Two

8:30 - 9:15	Welcome Back & Morning Check-In
9:15 - 9:45	Teaching Garden Tour
9:45 - 11:00	Develop a Personal STEM^3 Activity
11:00 - 12:30	Conservatory & Museum Tour with Lunch *(Museum of Tulsa History)*
12:45 - 2:15	Peer Group Review Activities
2:15 - 2:45	Group Highlights & Presentations
2:45 - 3:30	Equity & AI in STEM Education
3:30 - 4:00	Resources, Shared Takeaways & Closing

GROUP TASKS

Outdoor Classroom - Orienteering & Aquaponics, Introduction *(Why Nature-Based Learning Works)*

Tulsa County Parks - Food Web, GRC Discussion/OASS/Vertical Align/Integration

TRSA - Patterns in the Sky, OST Equity & Access, AI Rubrics

General Outcome Flow over the two days: BIG PICTURE

Day One

Introduction to the GRC Worksheet
Four Activity Rotations to Learn & Reinforce GRC Worksheet integrating OASS & NGSS
EOD Wrap Up and Homework - Come Back with One Activity to fully Develop

Day Two

Develop Personal Activity with proper NGSS and OASS CCCs and DCIs
Lunch at the Museum of Tulsa History
Small Group presentations of each Activity Worksheet Equity
(different learning styles) and AI for the mundane
Resources and Sharing

INTRODUCTION TO NGSS STEM^3

This workbook explores how to break down and understand the Next Generation Science Standard's (**NGSS**) 3 Dimensions of Science Learning using the **Science and Engineering Practices** (**SEPs**), **Disciplinary Core Ideas** (**DCIs**), and **Cross Cutting Concepts** (**CCCs**). These 3 dimensions together create the framework for **NGSS** and the Oklahoma Academic Science Standards (**OAS-S**) as we know them.

This workbook focuses on the **GRC** (Gather, Reason, Communicate) model that is applied to the **NGSS** framework to teach educators how to write a robust inquiry - based lesson plan using the 3 dimensions (**SEPs**, **DCIs**, **CCCs**).

Educators will use this workbook to learn how to connect **NGSS** and **OAS-S** to natural phenomena using the 3 dimensions. The **CCCs** are the connection between standards and phenomena. The **SEPs** are how we will gather evidence to communicate, and the **DCIs** are the objectives the students will know at the end of the lesson(s).

Finally, this workbook will also discuss how to work with all educators from your district to create a vertical alignment plan for all Science teachers from Pk-12 grades and how to work with fellow teachers across disciplines to integrate natural phenomena based curriculum across the content areas and all grade bands.

This workbook is a culmination of a 2-day workshop introducing and understanding the concept of the Next Generation Science Standards' Gather, Reason, Communicate lesson plan format using the 3 dimensions (**SEPs**, **DCIs**, **CCCs**) that we know as a standard. Educators will learn how to connect natural phenomena to standards by using cross-cutting concepts. Educators can then take this information back to their district and create an integrated vertical alignment plan that supports deep learning and the success of their students.

Happy Teaching!

NEXT GEN EDUCATION, LLC

Gather - Reason - Communicate (GRC) LESSON COACHING TEMPLATE - INSTRUCTIONAL ALIGNMENT TO THREE DIMENSIONS

The Gather, Reason, and Communicate Performance Sequence (Moulding & Bybee, 2017)

Gather	Students are provided with a relevant phenomenon or problem that acts as the launching point for them to (1) obtain information by asking questions and defining problems for causes of the phenomenon within and among systems; (2) investigate the interactions of components of systems to determine the changes in terms of flow of energy and cycling of matter; and (3) determine the proportion of components in systems and interactions/feedback among systems. Gathering may include reading, listening, investigating, and using models.
Reason	Students use information they gathered to make sense of phenomena. Reasoning includes analyzing data and information, constructing explanations for the causes(s)of the phenomenon, engineering solutions to problems, and developing arguments for how the evidence supports or refutes explanations or solutions. Reasoning occurs in our brains, but may utilize models, speaking, and writing to organize the relationship between the causes of phenomena and the evidence supporting the explanations.
Communicate	Students communicate their reasoning by developing arguments for how evidence supports explanations. Communicating includes speaking, writing, and/or models to present explanations and arguments to themselves and others.

Moulding, B. & Bybee, R. (2017). *Teaching Science is Phenomenal*. ELM Tree Publishing: Washington, UT. ISBN:978-0-8890674-0-6

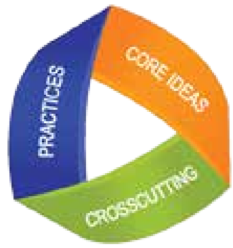
MAKING CONNECTIONS

3-Dimensional Learning:

"The National Research Council's (NRC) **Framework** describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. **It presents three dimensions that will be combined to form each standard"**. (NGSS website: https://www.nextgenscience.org/) The *Gather-Reason-Communicate* Lesson plan template is an instructional alignment to the 3-Dimensions

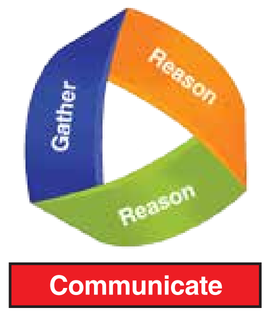
Dimension 1: Practices (Science and engineering Practices; SEP)

Gather (Includes SEP's)



Dimension 2: Cross Cutting Concepts (CCC)

Reason (Includes CCC's and DCI's)

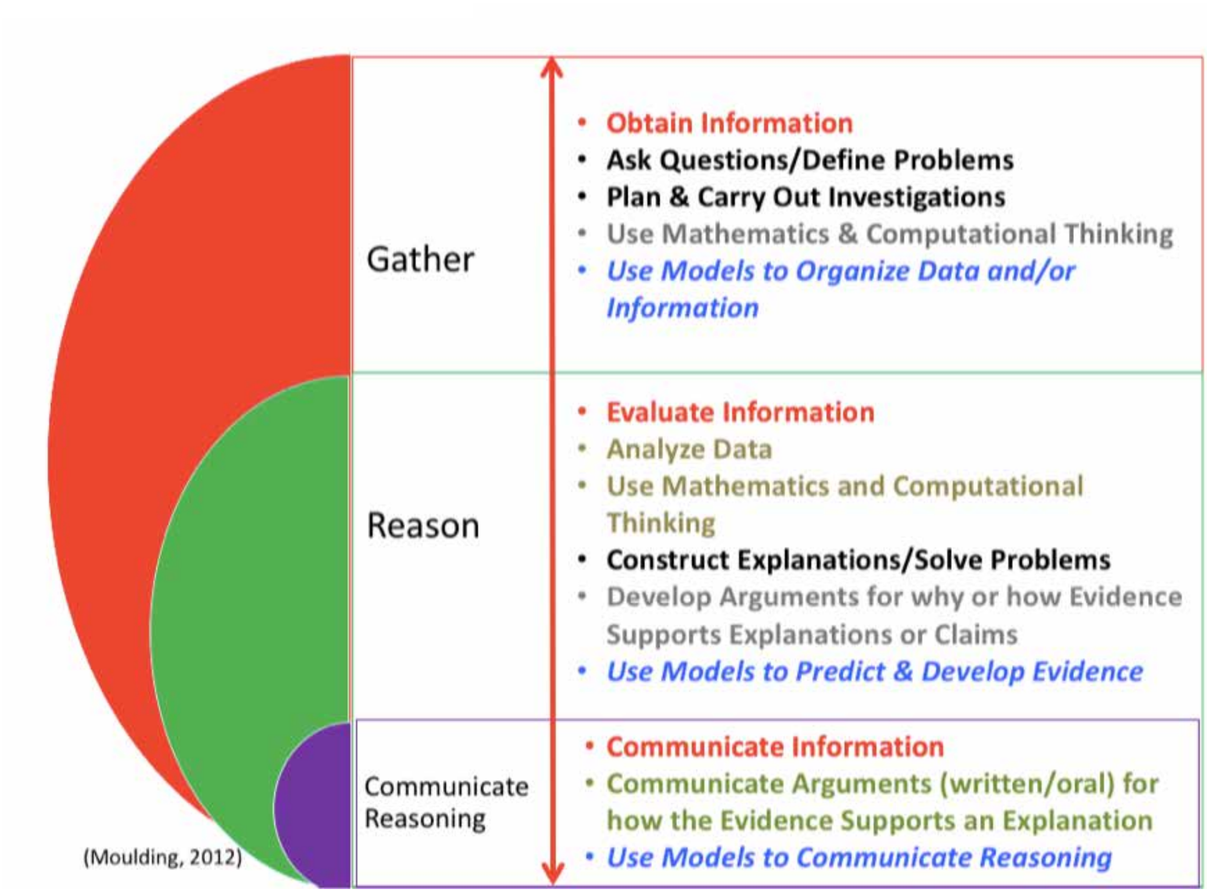


Dimension 3: Disciplinary Core Ideas (DCI)

Communicate (Evidence from all 3 to communicate results)

NEXT GEN EDUCATION, LLC

Gather - Reason - Communicate (GRC) LESSON COACHING TEMPLATE - INSTRUCTIONAL ALIGNMENT TO THREE DIMENSIONS



CONNECTING CROSS CUTTING CONCEPTS TO NATURAL PHENOMENA

WHAT ARE PHENOMENA IN SCIENCE AND ENGINEERING?

- **Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict. The goal of building knowledge in science is to develop general ideas, based on evidence, that can explain and predict phenomena.**
- **Engineering involves designing solutions to problems that arise from phenomena, and using explanations of phenomena to design solutions.**
- **In this way, phenomena are the context for the work of both the scientist and engineer.**

Cross Cutting Concepts (CCC's) are the connection to matching a standart to a natural phenomena. Pick a natural phenomenon and use this page to pick a CCC that connects with it.

1. Patterns
2. Cause and Effect
3. Scale, Proportions, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

Name the phenomenon

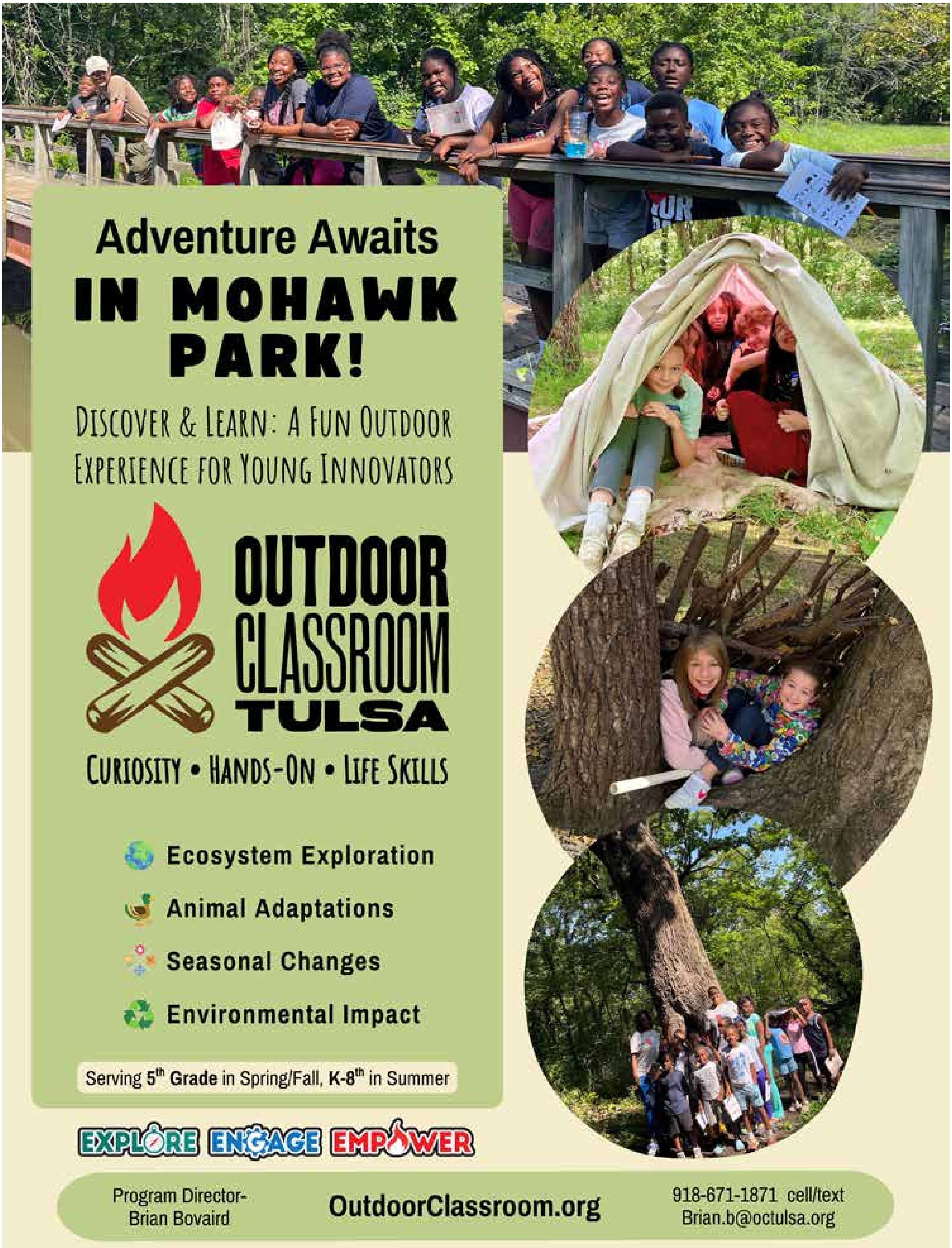
____
____
____
____

Describe the phenomenon

____
____
____
____

Cross Cutting Concepts to connect the natural phenomenon

____
____
____
____


Adventure Awaits
IN MOHAWK PARK!
DISCOVER & LEARN: A FUN OUTDOOR EXPERIENCE FOR YOUNG INNOVATORS
OUTDOOR CLASSROOM TULSA
CURIOSITY • HANDS-ON • LIFE SKILLS
Ecosystem Exploration
Animal Adaptations
Seasonal Changes
Environmental Impact
Serving 5th Grade in Spring/Fall, K-8th in Summer
EXPLORE ENGAGE EMPOWER
Program Director-
Brian Bovaird
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Orienteering & Spatial Thinking

Participants navigate a defined outdoor course using maps and compasses, collect distance and direction data, and observe how spatial tools support problem-solving.

Oklahoma Academic Standards

1st Grade	5th Grade	8th Grade	High School
1.ESS1.1 Use observations of the Sun, Moon, and stars to describe patterns that can be predicted.	**5.ESS1.2** Represent data in graphical displays to reveal patterns of daily changes in the length and direction of shadows, in addition to different positions of the Sun, Moon, and stars at different times of the day, month, and year.	**8.ESS1.1** Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons.	**EN.ESS2.3** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

NGSS

- ★ **5-ESS1-1** Support an argument that differences in apparent brightness of stars are due to relative distances.
- ★ **5-ESS-1-2** Represent data to reveal patterns of daily changes in shadows and day/night.

OASS

- ★ **5.ESS1.1** Support an argument that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth.
- ★ **5.ESS1.2** Represent data to reveal patterns of daily changes in length and direction of shadows, day and night, and seasonal appearance of some stars.

Gather

Science & Engineering Practices (SEPs):

NGSS

- ★ Analyze and Interpret Data.
- ★ Developing and Using Models.

OASS

- ★ Analyze and Interpret Data.
- ★ Developing and Using Models.

Reason

Disciplinary Core Ideas (DCIs): Students Will Be Able To Understand

NGSS

- ★ **5-ESS-1-2** The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.

OASS

- ★ **5.ESS1.2** The Sun is a star that appears brighter than other stars because it is closer to Earth. The Sun is a star that appears larger than other stars because it is closer to Earth. Stars range greatly in their distance from Earth. The orbits of Earth around the Sun and of the Moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night, daily changes in the length and direction of shadows, and different positions of the Sun, Moon, and stars at different times of the day, month, and year.

Crosscutting Concepts (CCCs):

NGSS

- ★ Patterns. (Observable patterns in shadows and daylight can be used to determine direction and time). *(5-ESS1-2)*
- ★ Scale, Proportion, and Quantity. (Measurement of distance and direction supports navigation and spatial reasoning).

OASS

- ★ Patterns. (Patterns in shadows, direction, and movement help predict location and orientation.)
- ★ Scale, Proportion, and Quantity. (Distance, direction, and measurement influence route selection and navigation decisions.)

Communicate

Communicate with evidence from Gather and Reason

Integration Across Disciplines

ELA/Literacy

- ★ **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-ESS1-2)* •**SL.5.5** Include multimedia components (e.g., maps, diagrams, visual displays) in presentations when appropriate to enhance the development of main ideas or themes. *(5-ESS1-2)*

Mathematics

- ★ **MP.2** Reason abstractly and quantitatively. *(5-ESS1-2)* •**MP.4** Model with mathematics. *(5-ESS1-2)*

Student Journaling Prompts

- Where does the magnetic needle on the compass always point?
- Why does the sun appear to move across the sky?
- What causes the magnetic needle to move?

Target Grade: **Course:**	**Lesson Title:** **Developed by:** **School:**
Performance Expectation(s) (Standard) from State Standards or NGSS:	
Lesson Performance Expectations	
Materials:	
Investigative Phenomenon	
Gather Phase (SEP, Engage/Explore)	
What is the Teacher Doing?	***What are the Students Doing?***
In the Classroom *List the practices that the students will be using in the Gather phase.*	***In the Classroom***
Reason Phase (DCI/CCC, Explain/Elaborate)	
In the Classroom *List the practices that the students will be using during the Reason phase.*	***In the Classroom***
Communicate Phase (Evaluate)	
In the Classroom *List the practices that the students will be using during the Communicate phase. Use the following*	***In the Classroom***
Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:	
Assessment of Student Learning	

NOTES

"Outdoor youth programs foster powerful social-emotional growth and life skills, especially when intentional reflection and youth development practices are combined with physically and emotionally challenging group experiences." *Grantmakers for Thriving - October 2025*

Nature Conservation and Education at Chandler Park

Hands-on, Minds-on & Inquiry-based Environmental Education in the Samuel Washington Woodhouse Nature Center at Chandler Park

How else can we support educators, students and communities?

Nature/Education Events

- Annual Earth Day Celebration
- Monarchs on the Mountain
- Women in Nature (WIN)

School-based Outreach

- Offsite Programs and Demos
- Professional Development
- Field Experiences
- Curriculum Design
- STEM/STEAM/Career Nights
- Field Trips to Chandler Park

Interpretive Nature/Education Programs

- Nature Babies
- Nature Plus
- 16-week Science & P.E. classes
- Interpretive Hikes

Contact:
Kim Watson, M.A., C.I.G.
Activities Coordinator & Naturalist
kwatson@tulsacounty.org
918-591-6053

Patrick T. Hayes, C.I.G.
Tulsa County Parks Naturalist
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918-591-6051

Fueling the Food Webs, Energy Flow Through the Ecosystem

Energy Flow through trophic levels, food webs, ecological interactions, human interactions with the environment.

Oklahoma Academic Standards

Kinder	3rd Grade	6th Grade	High School
K.LS1.1 Use observations to describe patterns of what plants and animals (including humans) need to survive.	3.LS1.1 Develop and use models to describe that organisms have unique and diverse life cycles but all have a common pattern of birth, growth, reproduction, and death.	6.LS1.3 Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	B.LS1.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. B.LS2.4 Use a mathematical representation to support claims for the cycling of matter and the flow of energy among organisms in an ecosystem.

NGSS

★ **5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

OASS

★ **5.LS2.1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

★ **5.LS2.2** Use models to explain or predict factors that upset the stability of local ecosystems.

Gather

Science & Engineering Practices (SEPs):

NGSS

★ Develop a model to describe phenomena.

★ Science explanations describe the mechanisms for natural events.

OASS

★ Develop a model to describe phenomena.

★ Develop a model to describe or predict phenomena.

Reason

Disciplinary Core Ideas (DCIs): Students Will Be Able To Understand

NGSS

★ **LS2.A**: Interdependent Relationships in Ecosystems- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. *(5-LS2-1)*

★ **LS2.B**: Cycles of Matter and Energy Transfer in Ecosystems- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)

OASS

★ The food of almost any kind of animal can be traced back to plants •Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. •Some organisms, such as fungi and bacteria, break down dead organisms (both plants, plant parts, and animals) and therefore operate as "decomposers." •Decomposition eventually restores (recycles) some materials back to the soil. •A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. •Matter cycles between the air and soil, and among plants, animals, and microbes as these organisms live and die. •Organisms can survive only in environments in which their particular needs are met. •A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. •Newly introduced species can damage the balance of an ecosystem.

Crosscutting Concepts (CCCs):

NGSS

★ Systems and System Models. (A system can be described in terms of its components and their interactions). (5-LS2- 1)

OASS

★ System and System Models. (A system can be described in terms of its components and their interactions).

★ Energy and matter. (Matter is transported into, out of, and within systems).

Communicate

Communicate with evidence from Gather and Reason

Integration Across Disciplines

ELA/Literacy

★ **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-LS2- 1)* •**SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5- LS2-1)*

Mathematics

★ **MP.2** Reason abstractly and quantitatively. *(5-LS2-1)* •**MP.4** Model with mathematics. *(5-LS2-1)*

Student Journaling Prompts:

- How does energy flow through the ecosystem?
- What do trophic levels mean?
- What animal group is the base for life?

Target Grade:	Lesson Title: Developed by: School:
Course:	
Performance Expectation(s) (Standard) from State Standards or NGSS:	
Lesson Performance Expectations	
Materials:	
Investigative Phenomenon	
Gather Phase (SEP, Engage/Explore)	
What is the Teacher Doing?	*What are the Students Doing?*
In the Classroom *List the practices that the students will be using in the Gather phase.*	*In the Classroom*
Reason Phase (DCI/CCC, Explain/Elaborate)	
In the Classroom *List the practices that the students will be using during the Reason phase.*	*In the Classroom*
Communicate Phase (Evaluate)	
In the Classroom *List the practices that the students will be using during the Communicate phase. Use the following*	*In the Classroom*
Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:	
Assessment of Student Learning	

NOTES

"Programs that center authentic relationships, among peers and with supportive adults, see youth develop a sense of purpose and responsibility, not by being told what to do, but because "it's natural when given freedom and safety." - GFT

Blue Thumb Water Quality Education Program

https://bluethumbok.com

https://bluethumbok.com/request-a-program.html

Stream Protection through Education

Aquaponics & Human-Centered Design

Participants explore an aquaponics system to understand nutrient cycling, energy flow, and human-centered design decisions.

Oklahoma Academic Standards

Kinder	5th Grade	7th Grade	High School
K.ESS3.1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.	5.LS2.2 Use models to explain or predict factors that upset the stability of local ecosystems.	7.LS2.2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	B.LS1.3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis in living organisms.

NGSS

- ★ **5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- ★ **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

OASS

- ★ **5.LS2.1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- ★ **5.LS2.2** Use models to explain factors that upset the stability of local ecosystems.
- ★ **G35.ETS1.1** Define a simple design problem reflecting a need or want that includes specified criteria for success and constraints on materials, time, or cost.

Gather

Science & Engineering Practices (SEPs):

NGSS

- ★ Developing and Using Models
- ★ Asking Questions and Defining Problems

OASS

- ★ Developing and Using Models
- ★ Asking Questions and Defining Problems

Reason

Disciplinary Core Ideas (DCIs): Students Will Be Able To Understand

NGSS

- ★ **LS2.A:** Interdependent Relationships in Ecosystems- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs, and decomposers recycle matter back into the environment. **LS2.B**: Cycles of Matter and Energy Transfer in Ecosystems- Matter cycles among plants, animals, decomposers, and the environment. Energy flows through ecosystems. **ETS1.A** 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.

OASS

- ★ **5.LS2.2** A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. •Matter cycles between the air and soil, and among plants, animals, and microbes as these organisms live and die. •Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. •Organisms can survive only in environments in which their particular needs are met. •A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. •Newly introduced species can damage the balance of an ecosystem. •Possible solutions to a problem are limited by available materials and resources (e.g., constraints). The success of a designed solution is determined by considering the desired features of a solution (e.g., 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.

Crosscutting Concepts (CCCs):

NGSS

- ★ Systems and System Models. (Models represent interacting components of natural and designed systems.)
- ★ Influence of Science, Engineering, and Technology on Society and the Natural World.

OASS

- ★ Systems and System Models. (Aquaponics systems are made up of interacting biological and mechanical components.)
- ★ Structure and Function

Communicate

Communicate with evidence from Gather and Reason

Integration Across Disciplines

ELA/Literacy

- ★ **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-LS2-1) •**SL.5.5** Include multimedia components (e.g., diagrams, models, visuals) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-LS2-1)

Mathematics

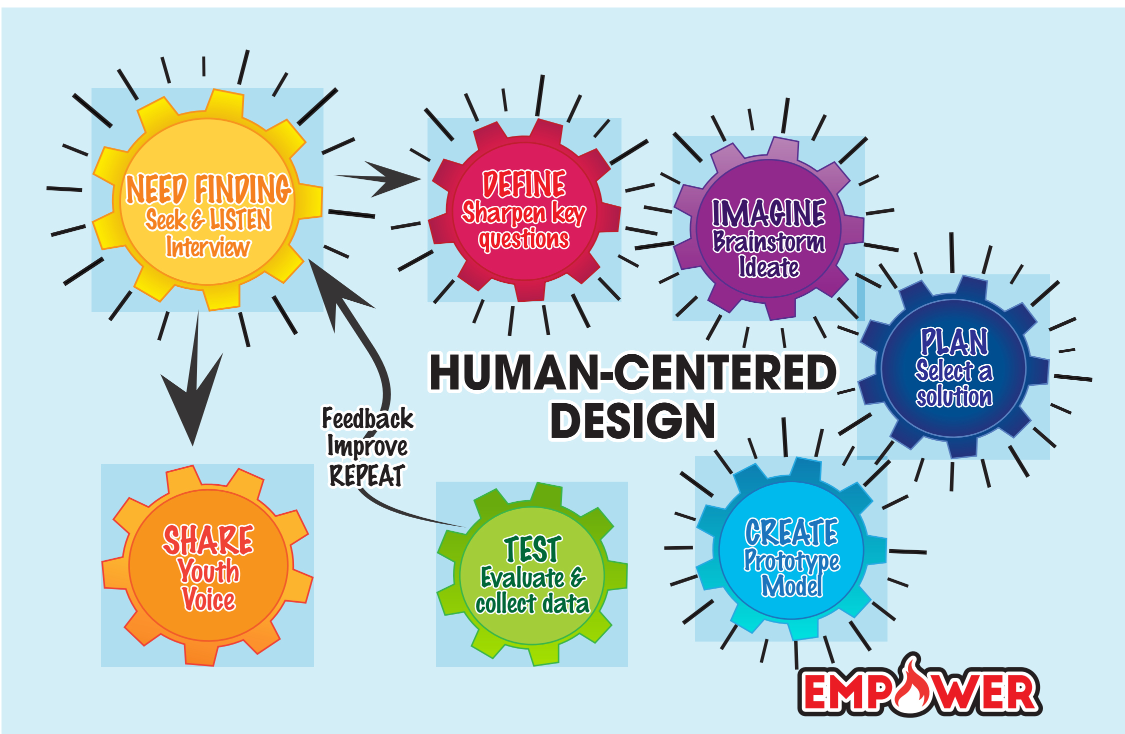
- ★ ***MP.2** Reason abstractly and quantitatively. (5-LS2-1) •**MP.4** Model with mathematics. (5-LS2-1)*

Student Journaling Prompts:

- Let's bring something to life! What do producers and consumers need in common +1?
- What does an Engineer do different from a Scientist?
- Posit a real life problem with data reference to solve? Gain concurrence.

Target Grade:	**Lesson Title:** **Developed by:** **School:**
Course:	
Performance Expectation(s) (Standard) from State Standards or NGSS:	
Lesson Performance Expectations	
Materials:	
Investigative Phenomenon	
Gather Phase **(SEP, Engage/Explore)**	
What is the Teacher Doing?	***What are the Students Doing?***
In the Classroom *List the practices that the students will be using in the Gather phase.*	***In the Classroom***
Reason Phase **(DCI/CCC, Explain/Elaborate)**	
In the Classroom *List the practices that the students will be using during the Reason phase.*	***In the Classroom***
Communicate Phase **(Evaluate)**	
In the Classroom *List the practices that the students will be using during the Communicate phase. Use the following*	***In the Classroom***
Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:	
Assessment of Student Learning	

NOTES



"As technology advances and the world changes, there are fewer opportunities for youth to realize that there's more beyond the world of their phone, school, stress about their future. These programs are a chance to unplug and experience a whole mind-body reset."

—**Illa Ranjan,** Conservation and Restoration Ecology student, Utah State University

Weathering the Storm

Observing Patterns in the Sky

Participants observe cloud formations, estimate coverage, and use these observations to forecast rain and other weather conditions.

Oklahoma Academic Standards

K-2nd	3rd-5th	6th -8th	9th-12th
2.PS1.1 - Matter can be described and classified by its observable properties.	5PS1.1 - A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations including inflation and shape of a balloon; the effect of air on larger particles or objects.	6.PS1.4 - Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	PS.PS1.1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

NGSS

- ★ **MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- ★ **MS-PS1-4**. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- ★ **MS-ESS2-4**. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- ★ **MS-ESS2-5**. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

OASS

- ★ **6.PS1.4** - Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- ★ **6.ESS2.4** - Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- ★ **6.ESS2.5** - Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

Gather

Science & Engineering Practices (SEPs):

NGSS

- ★ Engaging in argument from evidence
- ★ Constructing Explanations and Designing Solutions
- ★ Developing and Using Models -
- ★ Analyzing and Interpreting Data
- ★ Mathematics and Computational Thinking

OASS

- ★ Engaging in Scientific Argument from Evidence -
- ★ Constructing Explanations and Designing Solutions
- ★ Developing and Using Models
- ★ Analyzing and Interpreting Data
- ★ Mathematics and Computational Thinking.

Reason

Disciplinary Core Ideas (DCIs): Students Will Be Able To Understand

NGSS

- ★ **MS-PS1.A**: Structure and Properties of Matter. Matter is made of particles too small to be seen. The arrangement and motion of particles determine whether matter is solid, liquid, or gas. Changes of state occur when thermal energy is added or removed, changing particle motion. **•MS-PS3.A:** Definitions of Energy Thermal energy is the energy associated with the motion of particles. Heat is the transfer of thermal energy due to temperature differences.**•MS-ESS2.C**: The Roles of Water in Earth's Surface Processes -Water cycles through Earth's systems via evaporation, condensation, precipitation, and runoff. Gravity and energy from the sun drive these processes.**•MS-ESS2.A**: Earth's Materials and Systems Earth's systems interact, with water moving between the atmosphere, hydrosphere, geosphere, and biosphere. **•MS-ESS2.D**: Weather and Climate Weather is influenced by interactions among air masses, the ocean, landforms, and energy from the sun. Weather patterns vary by latitude, altitude, and geography. Because of system complexity, weather predictions are probabilistic. **•MS-ESS2.A**: Earth's Materials and Systems (secondary alignment) The atmosphere interacts dynamically with other Earth systems, producing observable weather patterns.

OASS

- ★ **6.PS1.4** - Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. **•6ESS2.4** - Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, and crystallization, and precipitation, as well as downhill flows on land. **•6ESS2.5** - Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. Because these patterns are so complex, weather can only be predicted probabilistically.

Crosscutting Concepts (CCCs):

NGSS

- ★ Patterns
- ★ Cause and Effect
- ★ Systems and System Models
- ★ Energy and Matter
- ★ Stability and Change

OASS

- ★ Patterns
- ★ Cause and Effect
- ★ Systems and System Models
- ★ Energy and Matter
- ★ Stability and Change

Communicate

Communicate with evidence from Gather and Reason

Integration Across Disciplines

Mathematics

- ★ **6.N.1.4** - Determine equivalencies among fractions, mixed numbers, decimals, and percents. **6.N.2.6** - Determine the greatest common factors and least common multiples. Use common factors and multiples to calculate with fractions, find equivalent fractions, and express the sum of two-digit numbers with a common factor using the distributive property. **6.N.3.3** - Apply the relationship between ratios, equivalent fractions, unit rates, and percents to solve problems in various contexts. **6.N.4.1** - Estimate solutions to problems with whole numbers, decimals, fractions, and mixed numbers, and use the estimates to assess the reasonableness of results in the context of the problem. **6.N.4.4** - Use mathematical modeling to solve and interpret problems including money, measurement, geometry, and data requiring arithmetic with decimals, fractions and mixed numbers.

Student Journaling Prompts

- Why do some clouds rain and some don't?
- Why do clouds look different?
- How do meteorologists forecast cloud cover?

Target Grade:	Lesson Title: Developed by: School:
Course:	
Performance Expectation(s) (Standard) from State Standards or NGSS:	
Lesson Performance Expectations	
Materials:	
Investigative Phenomenon	
Gather Phase (SEP, Engage/Explore)	
What is the Teacher Doing?	*What are the Students Doing?*
In the Classroom *List the practices that the students will be using in the Gather phase.*	*In the Classroom*
Reason Phase (DCI/CCC, Explain/Elaborate)	
In the Classroom *List the practices that the students will be using during the Reason phase.*	*In the Classroom*
Communicate Phase (Evaluate)	
In the Classroom *List the practices that the students will be using during the Communicate phase. Use the following*	*In the Classroom*
Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:	
Assessment of Student Learning	

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Gather - Reason - Communicate (GRC)

LESSON COACHING TEMPLATE - INSTRUCTIONAL ALIGNMENT TO THREE DIMENSIONS

Target Grade:	**Lesson Title:** **Developed by:** **School:**
Course:	
Performance Expectation(s) (Standard) from State Standards or NGSS:	
Lesson Performance Expectations	
***Materials*:**	
Investigative Phenomenon	
Gather Phase	
What is the Teacher Doing?	***What are the Students Doing?***

BLOSSOMS Lesson Template

NEXT GEN EDUCATION, LLC

Gather - Reason - Communicate (GRC)

LESSON COACHING TEMPLATE - INSTRUCTIONAL ALIGNMENT TO THREE DIMENSIONS

In the Classroom *List the practices that the students will be using in the Gather phase.*	***In the Classroom***
Reason Phase	
In the Classroom *List the practices that the students will be using during the Reason phase.*	***In the Classroom***
Communicate Phase	
In the Classroom *List the practices that the students will be using during the Communicate phase. Use the following*	***In the Classroom***

BLOSSOMS Lesson Template

Coaching Template ©Next Gen Education LLC

NEXT GEN EDUCATION, LLC

Gather - Reason - Communicate (GRC)

LESSON COACHING TEMPLATE - INSTRUCTIONAL ALIGNMENT TO THREE DIMENSIONS

Suggested Prompts Using Crosscutting Concepts to Structure Student Thinking:
Assessment of Student Learning

NOTES

“We call it quantitative literacy, just knowing which fraction is larger or smaller, that the slope is positive when it is going up,” Janine Wilson, the chair of the undergraduate economics program at UC Davis, told me. “Things like that are just kind of in our bones when we are college ready. We are just seeing many folks without that capability.”

Part of what’s happening here is that as more students choose STEM majors, more of them are being funneled into introductory math courses during their freshman year. But the national trend is very clear: America’s students are getting much worse at math. *Atlantic*, November 19,2025

BACKYARD BIODIVERSITY

Tulsa Regional STEM Alliance

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This activity aligns with the following Oklahoma Academic Standards:

- Crosscutting Concepts: Scale, Proportion, and Quantity
- Science and Engineering Practices: Planning and Carrying out Investigations
- 2nd Grade Biological Unity and Diversity 2.LS4.1
- 3rd Grade Biological Unity and Diversity 3.LS4.4
- 5th Grade Ecosystems: Interactions, Energy, and Dynamics 5LS2.2
- 7th Grade Ecosystems: Interactions, Energy, and Dynamics 7.LS2.5
- HS Environmental Science, Ecosystems: Interactions, Energy, and Dynamics EN.LS2.7

Biodiversity is the variety of life on Earth. Every living thing, including humans, has a role in the ecosystem called its **niche.** Some ecosystems have many types of species that have similar niches, and some ecosystems may only have one type of species that can fill a certain niche. Ecosystems with many different types of species and many different niches have a greater biodiversity. The greater the biodiversity of an ecosystem, the healthier and more stable that ecosystem becomes.

Humans depend on biodiversity in many different ways, such as pollination, climate regulation, air and water purification, food, medicine, and so much more! Humans also threaten biodiversity in many ways such as deforestation, habitat destruction, pollution, and by creating monocultures. A **monoculture** is when an area is covered by only one type of plant. With only one species of plant available in an area, animals don't have many options for food or shelter. Creating a monoculture limits the number of niches for animals, weakening the health of the ecosystem.

Scientists monitor biodiversity by tracking population sizes of both plants and animals. But how can we possibly count every single organism on Earth? It's easy - we don't! Scientists use **sampling techniques** and math to estimate population sizes. Instead of counting the number of species in an entire ecosystem, scientists only count the number of species in a small area called a **quadrat.**

An average is taken from several quadrats to estimate the number of species in the entire ecosystem. These estimates can be used to determine the health of the ecosystem and of the populations that reside within them.

The goal

In this activity, you will analyze the biodiversity of an area using a sampling technique called a **quadrat**.

Did you know?

70% of new medicines come from natural sources, including antibiotics, and treatment for diabetes, HIV, cancer, and more!

What you need

- A sheet of cardstock, chipboard, or recycled cardboard like from a cereal box
- A ruler
- Scissors
- Tape
- Pencil
- Paper or notebook to record observations
- A hand lens or magnifying glass (optional)

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Instructions

1.Use a ruler and scissors to divide the sheet of cardstock or cardboard into 4 long, equal strips. Each strip should be about 2 inches wide. Rather than using strips you could also carefully cut a neat square out of the center of the cardboard.

2. Tape the ends of the strips together at right angles, creating a square. This is your quadrat. Typically a quadrat is one square meter, but ours is smaller. You can find the area of your quadrat by measuring and multiplying the length and width of the open area.

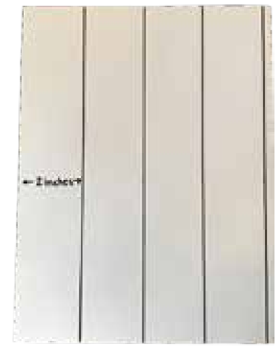
3. Take the quadrat to a grassy area. This can be any patch of ground that contains plants, such as a yard, park, field, nature path, etc. If you are studying biodiversity in a nature preserve, make sure you follow the rules of the park so you don't harm any plants or animals.

4. Use the hand lens to examine the species within your quadrat. How many different types of plants do you see? It's okay if you don't know what each plant is called. Just count each one that looks different. Do you see any insects, worms, or other animals? Count those too! Remember they are also part of the ecosystem. Record your observations in a notebook. You can also sketch what you see!

5. Repeat steps 3 and 4 several more times in different spots of the area you are surveying.

6. When you are finished, total the number of observations. If you are working with others, combine and total everyone's observations.

2 inches wide



Think about

What can you conclude based on the results of your survey? How diverse is this ecosystem? Do you notice a large number of the same types of plants or animals? Is something missing in this area? Do you think your results would change if you sampled more areas? Understanding and reporting on the health of an ecosystem is just one important part of a biologist's job.

Measure opening and determine area (length x width)

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More to explore

- Use your quadrat to compare the biodiversity of a landscaped area such as a yard or park with a natural area like a field. Which type of ecosystem do you think will have the highest biodiversity? Would you consider either ecosystem to be a monoculture?
- Participate in a BioBlitz! Several times throughout the year, citizen scientists in Oklahoma help count species in their area and report their data back to biologists at the University of Oklahoma. Learn how you can participate at **okbiodiversity.org**.
- The app Seek by iNaturalist can help you identify species of plants and animals. It's free to download and also tracks and records your observations.

Did you know?

Fireflies, also called lightning bugs, are attracted to tall grasses. Mowing your yard too frequently can reduce the number of fireflies around your home. Fireflies help keep an ecosystem in balance and their presence may indicate a healthy ecosystem.

STEM Hero: Dr. Priscilla Crawford

Dr. Priscilla Crawford is a conservation biologist who conducts biological surveys and monitors rare, endangered, and invasive species throughout Oklahoma. She is a professor at the University of Oklahoma where she teaches Field Studies in Biological Conservation, has worked for the National Wildlife Federation and the U.S. Forest Service, and earned advanced degrees in ecology and biogeography. Dr. Crawford organizes BioBlitz! Oklahoma, an annual biodiversity education event. She also hosts a podcast that showcases experts and conservation efforts in Oklahoma. Learn more at **priscillacrawford.com**.

Credit: Priscilla Crawford/LinkedIn

Read All about it!

Many: The Diversity of Life on Earth
by Nicola Davies

Humans and Other Life on Earth: Sharing the Planet
by Ava Sawyer

www.TulsaSTEM.org

APPENDIX A: WHY NATURE-BASED LEARNING WORKS

Nature-based learning environments provide cognitive, emotional, and physiological benefits that support deeper learning. Research in neuroscience and educational psychology demonstrates that exposure to natural settings improves attention restoration, working memory, and self-regulation. These conditions are foundational for systems thinking and complex problem solving.

Observational studies show that learners in outdoor environments exhibit increased persistence, curiosity, and collaborative behaviors. Nature reduces extraneous cognitive load, allowing learners to devote more mental energy to reasoning, pattern recognition, and sensemaking.
Key observations for educators:

- Students ask more authentic questions when phenomena are tangible.
- Behavioral disruptions decrease as physical movement and sensory input increase.
- Learners demonstrate greater willingness to revise thinking.

Research References include Diamond (2013), Kuo et al. (2019), and Louv (2005).

APPENDIX B: OKLAHOMA ACADEMIC STANDARDS & VERTICAL ALIGNMENT

Vertical alignment ensures that learning experiences build coherently from early childhood through high school and into OST settings. STEM³ emphasizes recurring practices and concepts rather than isolated standards.
Observations across grade bands:

- K–2 learners focus on noticing patterns and asking questions.
- Grades 3–5 expand toward systems, measurement, and data interpretation.
- Grades 6–8 emphasize modeling, ratios, and cause–effect relationships.
- High school learners integrate complex systems, design solutions, and data-driven arguments.
- OST settings reinforce collaboration, workforce skills, and applied problem-solving.

Educators are encouraged to use this alignment to design lessons that anticipate future learning.

[Link to DCI Progression PDF]

[Link to SEP Progression PDF]

[Link to CCC Progression PDF]

Weathering The Storm

Observing Patterns in the Sky

Participants observe the appearances of clouds, estimate cloud cover, and apply these observations to forecasting weather conditions such as rain.

Next Generation Science Standards

Kinder	3rd Grade	Middle School	High School
K-ESS2-1 Use and share observations of local weather conditions to describe patterns over time.	**3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.	**MS-ESS2-5** Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.	**HS-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Science & Engineering Practices (SEPs)

Grade Level	Analyzing and Interpreting Data	Mathematics and Computational Thinking	Constructing Explanations and Designing Solutions
Kinder-2nd	Record information (thoughts, observations, and ideas). Use and share pictures, drawings, and/or writing of observations. Use observations to describe patterns and/or relationships in the natural world in order to answer scientific questions.	Describe, measure, and compare quantitative attributes of different objects and display the data using simple graphs. Use counting and numbers to identify and describe patterns in the natural world. Decide when to use qualitative vs. quantitative data.	Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.
3rd-5th	Represent data in tables and/or various graphical displays (bar graphs, pictographs, pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.	Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific questions. Organize simple data sets to reveal patterns that suggest relationships.	Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments). Use evidence (e.g., observations, patterns) to support an explanation.
6th-8th	Analyze concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data.	Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific questions. Use mathematical representations to describe and support scientific conclusions.	Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, simulations).
9th-12th	Apply concepts of statistics and probability (including determining function fits to data,	Use mathematical, computational, and/or algorithmic representations of	Use evidence (e.g., measurements, observations, patterns) to construct

	slope, intercept, and correlation coefficient to linear fits) to scientific questions. Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.	phenomena to describe and/or support claims and/or explanations. Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived and compound units (e.g., mg/mL, kg/m3, acre-feet).	or support an explanation.

Disciplinary Core Ideas (DCIs)

Kinder	3rd Grade	6th Grade	High School
Weather is the combination of sunlight, wind, snow, rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude and altitude, which can affect atmospheric flow patterns. Because these patterns are so complex, weather can only be predicted probabilistically.	The foundation for Earth's global climate system is the electromagnetic radiation from the Sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.

Crosscutting Concepts (CCCs)

Grade Level	Patterns	Cause and Effect	Systems and System Models
Kinder-2nd	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Simple tests can be designed to gather evidence to support/refute students' ideas about causes.	Systems in the natural and designed world have parts that work together.
3rd-5th	Similarities and differences in patterns can be used to sort, classify, communicate, and analyze natural phenomena. Patterns of change can be used to make predictions.	Cause and effect relationships are routinely identified, tested, and used to explain change.	A system can be described in terms of its components and their interactions.
6th-8th	Graphs, charts, and images can be used to identify patterns in data.	Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	Models are limited in that they only represent certain aspects of the system under study.
9th-12th	Mathematical representations are needed to identify some patterns.	Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Tulsa Regional STEM Alliance

Backyard Biodivisity

Next Generation Science Standards

2nd Grade	3rd-5th Grade	Middle School	High School
2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.	**3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.*	**MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	**HS-LS2-7** Design, evaluate, and refine a solution for reducing the impact of human activities on the environment and biodiversity.*

Science & Engineering Practices (SEPs)

Grade Level	Developing and Using Models	Planning and Carrying Out Investigations	Engaging in Argument from Evidence	Constructing Explanations and Designing Solutions
K-2nd	Develop a simple model based on evidence to represent a proposed object or tool.	Make observations (firsthand or from media) to collect data which can be used to make comparisons.	Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.
3rd-5th	Develop a model to describe or predict phenomena.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of phenomenon or test a design solution.	Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
6th-8th	Evaluate limitations of a model for a proposed object or tool. Develop or modify a model-based on evidence to match what happens if a variable or component of a system is changed.	Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.	Construct an explanation that included qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. Construct an explanation using models or representations.
9th-12th	Design a test of a model to ascertain its reliability.	Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.	Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).	Make quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Disciplinary Core Ideas (DCIs)

2nd	3rd-5th Grade	7th Grade	High School
Biodiversity and Humans There are many different kinds of living things in any area, and they exist in different	3rd Grade: Ecosystem Dynamics, Functioning, and Resilience When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources,	Ecosystem Dynamics, Functioning, and Resilience Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems.	Ecosystem Dynamics, Functioning, and Resilience Anthropogenic changes (induced by human activity) in the environment can disrupt an ecosystem and threaten the survival of some species.

places on land and in water.	some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. Biodiversity and Humans Populations live in a variety of habitats, and change in those habitats affects the organisms living there. Interdependence of Science, Engineering, and Technology Knowledge of relevant scientific concepts and research findings is important in engineering. 5th Grade: Interdependent Relationships in Ecosystems Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.	The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. Biodiversity and Humans Changes in biodiversity can influence human resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Influence of Science, Engineering, and Technology on Society and the Natural World The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values, by the findings of scientific research, and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	Biodiversity and Humans Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity, but human activity is also having adverse impacts on biodiversity. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. Developing Possible Solutions When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics, and to consider social, cultural, and environmental impacts.

Crosscutting Concepts (CCCs)

Grade	Systems & Models	Stability and Change
K-2nd	A system is an organized group of related objects or components.	Some things stay the same while other things change. Things may change slowly or rapidly.
3rd-5th	A system can be described in terms of its components and their interactions.	Change is measured in terms of differences over time and may occur at different rates. Some systems appear stable, but over long periods of time will eventually change.
6th-8th	Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions - such as inputs, processes, and outputs - and energy, matter, and information flows within the systems. Models are limited in that they only represent certain aspects of the system under study.	Small changes in one part of a system might cause large changes in another part.
9th-12th	Systems can be designed to do specific tasks. When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer) can be used to simulate systems and interactions; including energy, matter, and information flow within and between systems at different scales. Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.	Much of science deals with constructing explanations of how things change and how they remain stable.

Orienteering

Next Generation Science Standards

1st Grade	5th Grade	Middle School	High School
1-ESS1-1 Use observations of the Sun, Moon, and stars to describe patterns that can be predicted.	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in the length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.	**MS-ESS1-1** Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons.	**HS-ESS2-3** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Science & Engineering Practices (SEPs)

Grade	Developing and Using Models	Analyzing and Interpreting Data
Kinder-2nd	Distinguish between a model and the actual object, process, and/or events the model represents. Compare models to identify common features and differences. Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	Record information (observations, thoughts, and ideas). Use and share pictures, drawings, and/or writings of observations. Compare predictions (based on prior experiences) to what occurred (observable events).
3rd-5th	Develop and/or use models to describe and/or predict phenomena. Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
6th-8th	Evaluate limitations of a model for a proposed object or tool. Develop a model to describe unobservable mechanisms. Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods.
9th-12th	Design a test of a model to ascertain its reliability. Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.	Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Disciplinary Core Ideas (DCIs)

K-2	3-5	6-8	9-12
Patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted.	The orbits of Earth around the Sun and of the Moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night, daily changes in the length and	Patterns of the apparent motion of the Sun, Moon, and stars in the sky can be observed, described, predicted, and explained with models.	Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement

	direction of shadows, and different positions of the Sun, Moon, and stars at different times of the day, month, and year.		of denser materials toward the interior.

Crosscutting Concepts (CCCs)

Grade Level	Patterns	Scale, Proportion, and Quantity
Kinder-2nd	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower). Standard units are used to measure length.
3rd-5th	Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation.	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
6th-8th	Patterns can be used to identify cause and effect relationships. Graphs, charts, and images can be used to identify patterns in data.	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. Phenomena that can be observed at one scale may not be observable at another scale.
9th-12th	Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments.	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.

Aquaponics

Next Generation Science Standards

Kinder	5th Grade	Middle School	High School
K-ESS3-1 Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.	**5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	**MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	**HS-LS1-3** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Science & Engineering Practices (SEPs)

Grade	Developing and Using Models	Planning and Carrying Out Investigations	Constructing Explanations and Designing Solutions
K-2nd	Distinguish between a model and the actual object, process, and/or events the model represents. Compare models to identify common features and differences. Develop a simple model based on evidence to represent a proposed object or tool.	With guidance, plan and conduct an investigation in collaboration with peers Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal. Make predictions based on prior experiences.	Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. Generate and/or compare multiple solutions to a problem.
3rd-5th	Identify limitations of models. Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Make predictions about what would happen if a variable changes.	Apply scientific ideas to solve design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Construct an explanation of observed relationships
6th-8th	Evaluate limitations of a model for a proposed object or tool. Develop a model to describe unobservable mechanisms.	Collect data about the performance of a proposed object, tool, process or system under a range of conditions. Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.	Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for realworld phenomena, examples, or events.
9th-12th	Design a test of a model to ascertain its reliability. Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Develop a complex model that allows for manipulation and testing of a proposed process or system.	Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables. Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.	Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Disciplinary Core Ideas (DCIs)

K-2	3-5	6-8	9-12
Animals obtain food they need from plants or other animals. Plants need water and light.	Matter cycles between the air and soil and among organisms as they live and die.	Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.	If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state or become a very different ecosystem, depending on the complex set of interactions within the ecosystem.

Crosscutting Concepts (CCCs)

Grade	Patterns	Systems and System Models	Stability and Change
Kinder-2nd	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Systems in the natural and designed world have parts that work together.	Some things stay the same while other things change. Things may change slowly or rapidly.
3rd-5th	Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation.	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions.	Change is measured in terms of differences over time and may occur at different rates. Some systems appear stable, but over long periods of time will eventually change.
6th-8th	Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships.	Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study.	Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.
9th-12th	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.	When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.	Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system.

Food Web

Next Generation Science Standards

Kinder	3rd Grade	6th Grade	High School
K.LS1.1 Use observations to describe patterns of what plants and animals (including humans) need to survive.	3.LS1.1 Develop and use models to describe that organisms have unique and diverse life cycles but all have a common pattern of birth, growth, reproduction, and death.	6.LS1.3 Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	B.LS1.2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. B.LS2.4 Use a mathematical representation to support claims for the cycling of matter and the flow of energy among organisms in an ecosystem.

Science & Engineering Practices (SEPs)

Grade	Asking Questions and Defining Problems	Developing and Using Models	Analyzing and Interpreting Data
K-2nd	Ask questions based on observations to find more information about the natural and/or designed world(s). Ask and/or identify questions that can be answered by an investigation.	Distinguish between a model and the actual object, process, and/or events the model represents. Compare models to identify common features and differences. Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	Record information (observations, thoughts, and ideas). Use and share pictures, drawings, and/or writings of observations. Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
3rd-5th	Ask questions about what would happen if a variable is changed. Identify scientific (testable) and non-scientific (non-testable) questions. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Use prior knowledge to describe problems that can be solved.	Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Develop and/or use models to describe and/or predict phenomena. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
6th-8th	Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. to identify and/or clarify evidence and/or the premise(s) of an argument. to determine relationships between independent and dependent variables and relationships in models.	Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. Use and/or develop a model of simple systems with uncertain and less predictable factors. Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. Develop and/or use a model to predict and/or describe phenomena. Develop a model to describe unobservable mechanisms. Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Distinguish between causal and correlational relationships in data. Analyze and interpret data to provide evidence for phenomena.
9th-12th	Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. that arise from examining models or a theory, to clarify and/or seek additional information and relationships. to determine relationships, including quantitative relationships, between independent and dependent variables. to clarify and refine a model, an explanation, or an engineering problem.	Design a test of a model to ascertain its reliability. Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Develop a complex model that allows for manipulation and testing of a proposed process or system. Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.	

Disciplinary Core Ideas (DCIs)

K-2	3-5	6-8	9-12
LS1.A Structure and function: All organisms have external parts that they use to perform daily functions. LS1.C Organization for matter and energy flow in organisms: Animals obtain food they need from plants or other animals. Plants need water and light. LS2.A Interdependent relationships in ecosystems: Plants depend on water and light to grow, and also depend on animals for pollination or to move their seeds around. LS2.B Cycles of matter and energy transfer in ecosystems: [Content found in LS1.C and ESS3.A]	LS1.A Structure and function: Organisms have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction. LS1.C Organization for matter and energy flow in organisms: Food provides animals with the materials and energy they need for body repair, growth, warmth, and motion. Plants acquire material for growth chiefly from air, water, and process matter and obtain energy from sunlight, which is used to maintain conditions necessary for survival. LS2.A Interdependent relationships in ecosystems: The food of almost any animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants, while decomposers restore some materials back to the soil. LS2.B Cycles of matter and energy transfer in ecosystems: Matter cycles between the air and soil and among organisms as they live and die.	LS1.A Structure and function: All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions. LS1.C Organization for matter and energy flow in organisms: Plants use the energy from light to make sugars through photosynthesis. Within individual organisms, food is broken down through a series of chemical reactions that rearrange molecules and release energy. LS2.A Interdependent relationships in ecosystems: Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. Competitive, predatory, and mutually beneficial interactions vary across ecosystems but the patterns are shared. LS2.B Cycles of matter and energy transfer in ecosystems: The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.	LS1.A Structure and function: Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors. LS1.C Organization for matter and energy flow in organisms: The hydrocarbon backbones of sugars produced through photosynthesis are used to make amino acids and other molecules that can be assembled into proteins or DNA. Through cellular respiration, matter and energy flow through different organizational levels of an organism as elements are recombined to form different products and transfer energy. LS2.A Interdependent relationships in ecosystems: Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem. LS2.B Cycles of matter and energy transfer in ecosystems: Photosynthesis and cellular respiration provide most of the energy for life processes. Only a fraction of matter consumed at the lower level of a food web is transferred up, resulting in fewer organisms at higher levels. At each link in an ecosystem elements are combined in different ways and matter and energy are conserved. Photosynthesis and cellular respiration are key components of the global carbon cycle.

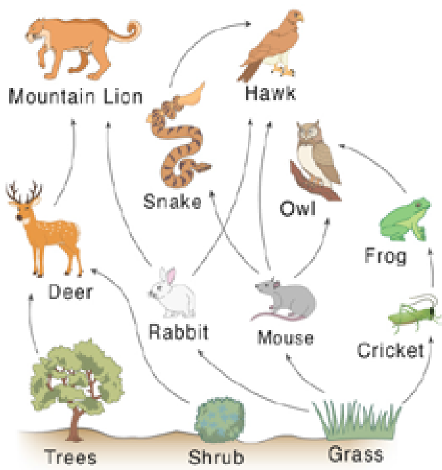
Crosscutting Concepts (CCCs)

Grade	Patterns	Systems and System Models	Energy and Matter	Structure and Function
K-2	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Objects and organisms can be described in terms of their parts. Systems in the natural and designed world have parts that work together.	N/A	The shape and stability of structures of natural and designed objects are related to their function(s).
3-5	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation.	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions.	Energy can be transferred in various ways and between objects.	Substructures have shapes and parts that serve functions.
6-8	Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs, charts, and images can be used to identify patterns in data.	Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.	Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system.	Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

9-12	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems.	Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

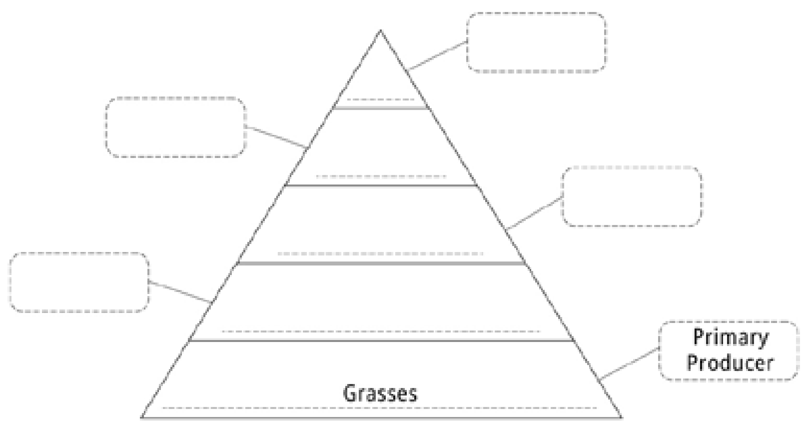
Trophic Levels in Food Chain

Direction 1: Use the food web to match each organism to its trophic level



Grass	Primary Consumer
Snake	Secondary Consumer
Cricket	Apex Predator
Frog	Primary Producer
Hawk	Tertiary Consumer

Direction 2: Place the names of each organism in the correct position in the food chain and also write their trophic levels



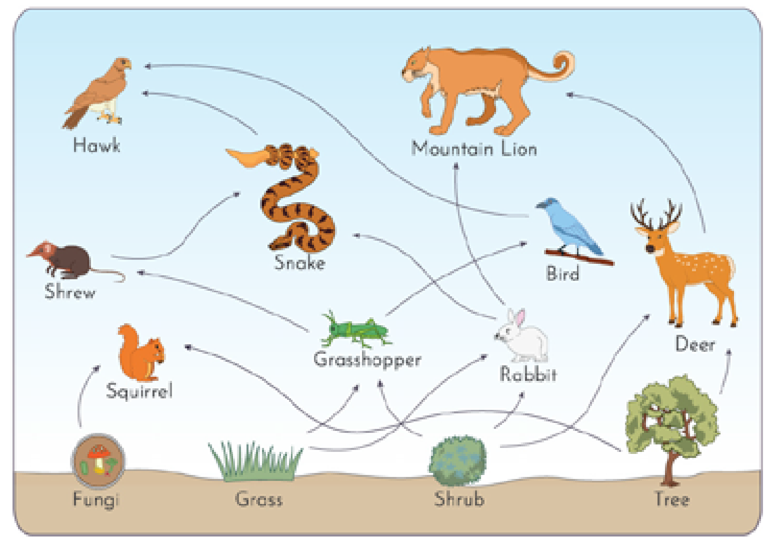
FOOD CHAIN WORKSHEET

~ Fill in the blank spaces. ~

① A food chain starts with a ________ and ends with a ________. Green plants are called ________ because they use the light energy of the sun to produce food using carbon dioxide and water through a process called ____________. Animals cannot make their food and thus are called ________.

② There are ___ main trophic levels in a food chain. They are ________, ________, ________________, and ______________. Apart from the said trophic levels, ____________ have no natural predators except humans. Then, __________, like fungi and bacteria, turn dead ____________ into inorganic materials in the soil.

~ Use the food web diagram below to answer the following questions. ~



① Write any two longest food chains in the food web.

____

____

Graphics by Science Facts

ORIENTEERING DATA

DATA COLLECTION/EXAMPLE QUESTIONS

ONE	
Answer:	
Bearing:	Paces:

TWO	
Answer:	
Bearing:	Paces:

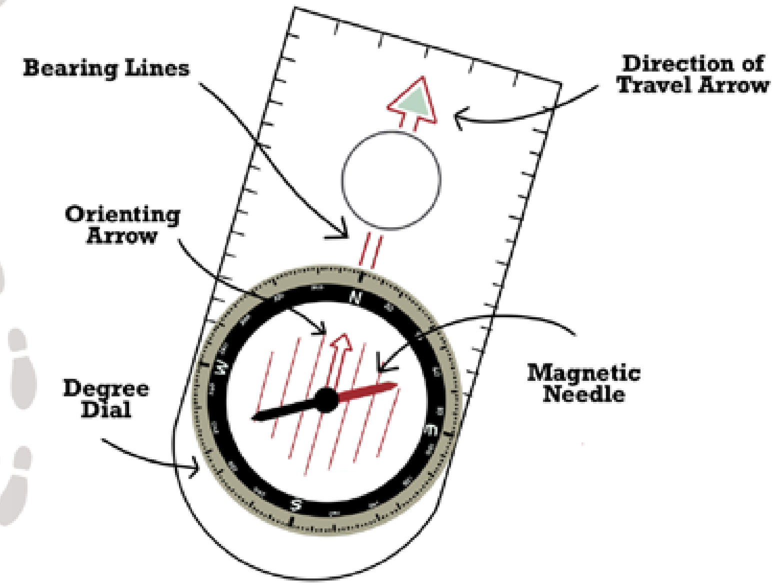
1. What are the four cardinal directions?
2. Where does the magnetic needle on the compass always point?
3. Why does the sun appear to move across the sky?
4. What causes the magnetic needle to move?

HOW TO CREATE A ROUTE

1. Point the direction of travel arrow the direction you want to have your route go.
2. Hold the compass level.
3. Rotate the dial until the orienting arrow lines up with the north end of the magnetic needle.
4. Write down the number the is between the two Bearing Lines, this is the bearing number you will give to students.

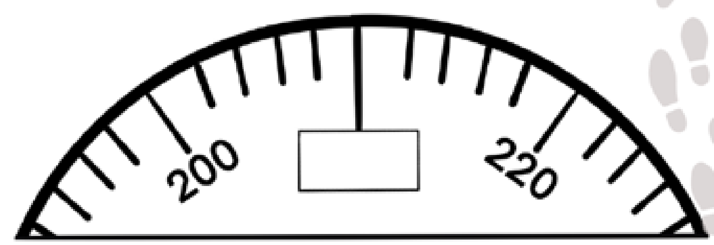
Bearing:	Paces:
Bearing:	Paces:

ORIENTEERING



HOW TO USE A COMPASS

1. Hold the compass level, and rotate the dial until the specified bearing (such as 240 degrees)is in between the two Bearing Lines.
2. Turn the compass, not the dial, until the orienting arrow lines up with the north end (usually red) of the magnetic needle.
3. Follow the direction-of-travel arrow toward your destination.
4. Periodically, recheck your bearing.

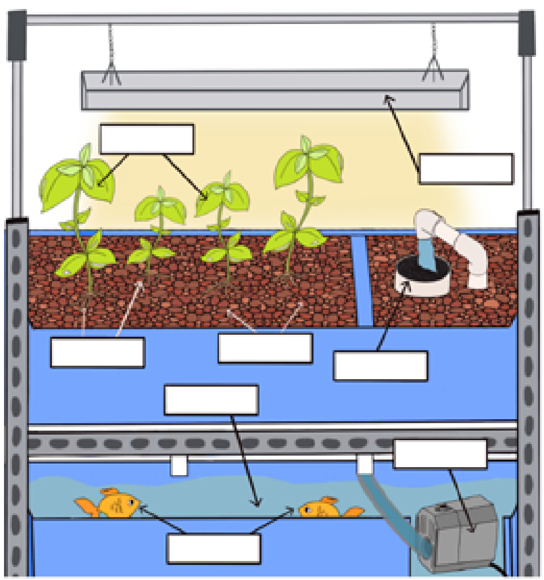


AQUAPONICS

Label the Aquaponic System

WORD BANK

Pump Leaf Filter Water Fish
Roots Media Light



AQUAPONICS

Circle the elements that you will find in an Aquaponics system.
Put an X through elements that may harm the ecosystem.

6 **C** Carbon 12.011	92 **U** Uranium 238.0289	8 **O** Oxygen 15.9994
17 **Cl** Chlorine 35.4527	1 **H** Hydrogen 1.0079	7 **N** Nitrogen 14.00674

Draw or list the four things all living ecosystems need to survive.

DESIGN THINKING

Engineer solutions that people and communities need

Need / Problem:

Define:

Imagine: Brainstorm

PLAN: Materials Needed

Create: Draw a Prototype / Model

Explain:

Appendix D: Artificial Intelligence as a Pedagogical Amplifier

In STEM³ professional learning, artificial intelligence is positioned as a positive, intentional tool that strengthens educator capacity and models future-ready practices for students. Rather than replacing instructional expertise, AI functions as a cognitive partner that supports modeling, assessment design, and impact measurement.

Using AI for Modeling & Instructional Design:
Educators can leverage AI to generate multiple representations of scientific models, support scenario testing, and visualize systems interactions. When educators transparently model how AI is used to explore ideas, revise thinking, and test assumptions, students learn ethical, critical, and reflective use of emerging technologies.

Using AI to Develop Rubrics & Feedback Tools:
AI can assist educators in drafting performance task rubrics aligned to Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. Educators retain decision-making authority by refining criteria, calibrating expectations, and ensuring equity. AI-generated drafts reduce time burdens while increasing clarity and coherence in assessment.

Using AI to Measure Short- and Long-Term Impact:
AI-supported analysis can help educators identify patterns in student work over time, such as growth in explanatory reasoning, use of evidence, and conceptual coherence. Short-term analysis may focus on formative feedback and revision cycles, while long-term analysis can inform program evaluation, instructional improvement, and reporting to stakeholders.

Key Observations for Educators:

- AI use is most effective when educators model transparency and critical evaluation.
- Rubric clarity improves when AI drafts are refined collaboratively.
- Longitudinal analysis supports evidence-based reflection on instructional impact.

This approach is informed by UNESCO (2023), Holmes et al. (2022), and emerging research on AI-supported assessment and learning analytics.

Tulsa Regional STEM Alliance

TULSA COUNTY
PARKS DEPARTMENT

EST. 2015
OUTDOOR CLASSROOM TULSA
CURIOSITY • HANDS-ON • LIFE SKILLS

"I went into the woods because I wished to live deliberately."

- Henry David Thoreau

RESOURCES