Core Standards FOR

Earth Science

Adopted October 2012 by

Utah State Board of Education

Utah Science Core Curriculum

Introduction
Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Science Core Curriculum places emphasis on understanding and using skills. Students should be active learners. It is not enough for students to read about science; they must do science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands-on, active experiences throughout the instruction of the science curriculum.

The Science Core describes what students should know and be able to do at the end of each course. It was developed, critiqued, piloted, and revised by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, expert national consultants, and an advisory committee representing a wide diversity of people from the community. The Core reflects the current philosophy of science education that is expressed in national documents developed by the American Association for the Advancement of Science and the National Academies of Science. This Science Core has the endorsement of the Utah Science Teachers Association. The Core reflects high standards of achievement in science for all students.

Organization of the Science Core
The Core is designed to help teachers organize and deliver instruction. Elements of the Core include the following:

- Each grade level begins with a brief course description.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for science skills and attitudes. They are found at the beginning of each grade, and are an integral part of the Core that should be included as part of instruction.
- The SCIENCE BENCHMARKS describe the science content students should know. Each grade level has three to five Science Benchmarks. The ILOs and Benchmarks intersect in the Standards, Objectives and Indicators.
- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they are judged to have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An INDICATOR is a measurable or observable student action that enables one to judge whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.
- SCIENCE LANGUAGE STUDENTS SHOULD USE is a list of terms that students and teachers should integrate into their normal daily conversations around science topics. These are **not** vocabulary lists for students to memorize.

Seven Guidelines Used in Developing the Science Core

Reflects the Nature of Science: Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Core is designed to produce an integrated set of Intended Learning Outcomes (ILOs) for students.

As described in these ILOs, students will:
- Use science process and thinking skills.
- Manifest science interests and attitudes.
- Understand important science concepts and principles.
- Communicate effectively using science language and reasoning.
- Demonstrate awareness of the social and historical aspects of science.
- Understand the nature of science.

Coherent: The Core has been designed so that, wherever possible, the science ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

Developmentally Appropriate: The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core describes science language students should use that is appropriate to their grade level. A more extensive vocabulary should not be emphasized. In the past, many educators may have mistakenly thought that students understood abstract concepts (such as the nature of the atom) because they repeated appropriate names and vocabulary (such as “electron” and “neutron”). The Core resists the temptation to describe abstract concepts at inappropriate grade levels; rather, it focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

Encourages Good Teaching Practices: It is impossible to accomplish the full intent of the Core by lecturing and having students read from textbooks. The Science Core emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should connect lessons with students’ daily lives. The Core directs experiential science instruction for all students, not just those who have traditionally succeeded in science classes.

Comprehensive: The Science Core does not cover all topics that have traditionally been in the science curriculum; however, it does provide a comprehensive background in science. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

Useful and Relevant: This curriculum relates directly to student needs and interests. It is grounded in the natural world in which we live. Relevance of science to other endeavors enables students to transfer skills gained from science instruction into their other school subjects and into their lives outside the classroom.

Encourages Good Assessment Practices: Student achievement of the standards and objectives in this Core is best assessed using a variety of assessment instruments. The purpose of an assessment should be clear to the teacher as it is planned, implemented, and evaluated. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform their instruction. Sample test items, keyed to each Core Standard, may be located on the Utah Science Home Page http://schools.utah.gov/curr/science/. Observation of students engaged in science activities is highly recommended as a way to assess students' skills as well as attitudes in science. The nature of the questions posed by students provides important evidence of students' understanding and interest in science.

Intended Learning Outcomes for High School Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

By the end of science instruction in high school, students will be able to:

1. Use Science Process and Thinking Skills

a. Observe objects, events and patterns and record both qualitative and quantitative information.
b. Use comparisons to help understand observations and phenomena.
c. Evaluate, sort, and sequence data according to given criteria.
d. Select and use appropriate technological instruments to collect and analyze data.
e. Plan and conduct experiments in which students may:
   - Identify a problem.
   - Formulate research questions and hypotheses.
   - Predict results of investigations based upon prior data.
   - Identify variables and describe the relationships between them.
   - Plan procedures to control independent variables.
   - Collect data on the dependent variable(s).
   - Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained.
   - Analyze data, check it for accuracy and construct reasonable conclusions.
   - Prepare written and oral reports of investigations.

f. Distinguish between factual statements and inferences.
g. Develop and use classification systems.
h. Construct models, simulations and metaphors to describe and explain natural phenomena.
i. Use mathematics as a precise method for showing relationships.
j. Form alternative hypotheses to explain a problem.

2. Manifest Scientific Attitudes and Interests

a. Voluntarily read and study books and other materials about science.
b. Raise questions about objects, events and processes that can be answered through scientific investigation.
c. Maintain an open and questioning mind toward ideas and alternative points of view.
d. Accept responsibility for actively helping to resolve social, ethical and ecological problems related to science and technology.
e. Evaluate scientifically related claims against available evidence.
f. Reject pseudoscience as a source of scientific knowledge.

3. **Demonstrate Understanding of Science Concepts, Principles and Systems**
    a. Know and explain science information specified for the subject being studied.
    b. Distinguish between examples and non-examples of concepts that have been taught.
    c. Apply principles and concepts of science to explain various phenomena.
    d. Solve problems by applying science principles and procedures.

4. **Communicate Effectively Using Science Language and Reasoning**
    a. Provide relevant data to support their inferences and conclusions.
    b. Use precise scientific language in oral and written communication.
    c. Use proper English in oral and written reports.
    d. Use reference sources to obtain information and cite the sources.
    e. Use mathematical language and reasoning to communicate information.

5. **Demonstrate Awareness of Social and Historical Aspects of Science**
    a. Cite examples of how science affects human life.
    b. Give instances of how technological advances have influenced the progress of science and how science has influenced advances in technology.
    c. Understand the cumulative nature of scientific knowledge.
    d. Recognize contributions to science knowledge that have been made by both women and men.

6. **Demonstrate Understanding of the Nature of Science**
    a. Science is a way of knowing that is used by many people, not just scientists.
    b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
    c. Science findings are based upon evidence.
    d. Understand that science conclusions are tentative and therefore never final. Understandings based upon these conclusions are subject to revision in light of new evidence.
    e. Understand that scientific conclusions are based on the assumption that natural laws operate today as they did in the past and that they will continue to do so in the future.
    f. Understand the use of the term "theory" in science, and that the scientific community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.
    g. Understand that various disciplines of science are interrelated and share common rules of evidence to explain phenomena in the natural world.
    h. Understand that scientific inquiry is characterized by a common set of values that include logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results and honest and ethical reporting of findings. These values function as criteria in distinguishing between science and non-science.
    i. Understand that science and technology may raise ethical issues for which science, by itself, does not provide solutions.

Science language students should use:	generalize, conclude, hypothesis, theory, variable, measure, evidence, data, inference, infer, compare, predict, interpret, analyze, relate, calculate, observe, describe, classify, technology, experiment, investigation, tentative, assumption, ethical, replicability, precision, skeptical, methods of science

Earth Science Core Curriculum

Life and physical science content are integrated in a curriculum with two primary goals: (1) students will value and use science as a process of obtaining knowledge based on observable evidence, and (2) students' curiosity will be sustained as they develop the abilities associated with scientific inquiry. This course builds upon students' experience with integrated science in grades seven and eight and is the springboard course for success in biology, chemistry, geology, and physics.

Theme

The theme for Earth Science is **systems.** The "Benchmarks" in the Earth Science Core emphasize "systems" as an organizing concept to understand life on Earth, geological change, and the interaction of atmosphere, hydrosphere, and biosphere. Earth Science provides students with an understanding of how the parts of a system through the study of the Earth's cycles and spheres. Earth's place in the universe as well its internal structure, tectonic plates, atmospheric processes, and hydrosphere are explored to help understand how Earth science interacts with society.

Inquiry

Throughout this course students experience science as a way of knowing based on making observations, gathering data, designing experiments, making inferences, drawing conclusions, and communicating results. Students see that the science concepts apply to their lives and their society. This course will provide students with science skills to make informed and responsible decisions. Students will learn how to explain cosmic and global phenomena in terms of interactions of energy, matter, and life. These explorations range from the realization that all elements heavier than helium were made in stars to an understanding of how rain influences a desert ecosystem. Throughout the course, the instructor should reference the evidence that scientists used to reach their conclusions (hypotheses, theories, etc.). The students should be able to answer the question "How do we know?".

Good science instruction requires hands-on science investigations in which student inquiry is an important goal. Teachers should provide opportunities for **all** students to experience many things. Students in Earth Science should design and perform experiments and value inquiry as the fundamental scientific process. They should be encouraged to maintain an open and questioning mind to pose their own questions about objects, events, processes, and results. They should have the opportunity to plan and conduct their own experiments, and come to their own conclusions as they read, observe, compare, describe, infer, and draw conclusions. The results of their experiments need to be compared for reasonableness to multiple sources of information. It is important for students at this age to begin to formalize the processes of science and be able to identify the variables in an experiment.

Relevance

Earth Science Core concepts should be integrated with concepts and skills from other curriculum areas. Reading, writing, and mathematics skills should be emphasized as integral to the instruction of science. Personal relevance of science in students' lives is an important part of helping students to value science and should be emphasized at this grade level. Developing students' writing skills in science should be an important part of science instruction in the ninth grade. Students should regularly write descriptions of their observations and experiments. Specific science literacy state standards can be found in the *Utah Core State Standards for English, Language Arts, & Literacy in History/Social Studies, Science and Technical Subjects for grades 6-12*.

Providing opportunities for students to gain insights into science related careers adds to the relevance of science learning. The topics in Earth Science introduce students to fundamental concepts related to careers in astronomy, geology, meteorology, hydrology, physical geography, and ecology. This is an excellent opportunity for students to broaden their understanding of careers in these areas.

Vocabulary Terms in Earth Science:
The Earth Science core highlights specific key concepts that are central to the understanding of the processes and themes of Earth's systems. These terms have been incorporated into the indicators and have been bolded and underlined. Students and teachers should integrate these terms into normal daily conversation around science topics. Terms that are repeated throughout multiple standards are highlighted in each standard the first time that they appear to support teachers as they utilize the core when planning their curriculum scope and sequence.

The Use of "i.e." versus "e.g." in the Core
"i.e." comes from the Latin *id est* and means "in other words" or "this and only this". Used in the Utah Core Science Curricula, i.e. is interpreted as a learning expectation of all students. The exemplars following an i.e. should be clearly and unambiguously taught in every classroom. In the CRTs, exemplars included in an i.e. statement are assessed as expected knowledge or skills.

"e.g." comes from the Latin *exampli gratia* and means "including" or "for example". Used in the Utah Core Science Curricula, e.g. is interpreted as a few possible examples of a larger context or concept. The exemplars following an e.g. are not required, but serve as examples for teaching the specific indicator. Several equally valid exemplars of the same concept may also be taught. In the CRTs, exemplars included as part of an e.g. may serve as the seeds of a good item, but clarifying contextual information will be provided in the item.

Character
Value for honesty, integrity, self-discipline, respect, responsibility, punctuality, dependability, courtesy, cooperation, consideration, and teamwork should be emphasized as an integral part of science learning. These relate to the care of living things, safety and concern for self and others, and environmental stewardship. Honesty in all aspects of research, experimentation, data collection, and reporting is an essential component of science.

Resources for Instruction
This Core was designed using the American Association for the Advancement of Science's *Project 2061: Benchmarks for Science Literacy* and the National Academy of Science's *National Science Education Standards* as guides to determine appropriate content and skills.

The Earth Science Core has three online resources designed to help with classroom instruction. These resources include the *Sci-ber Text,* an electronic science textbook; web resources listed by Core objective; and the science test item pool. This pool includes multiple-choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the Core. These resources are all aligned to the Core and available on the Utah Science Home Page at http://schools.utah.gov/CURR/science/default.aspx

Safety Precautions
The hands-on nature of science learning increases the need for teachers to use appropriate precautions in the classroom and field. Proper handling and disposal of chemicals is crucial for a safe classroom.

Appropriate Use of Living Things in the Science Classroom
It is important to maintain a safe, humane environment for animals in the classroom. Field activities should be well thought out and use appropriate and safe practices. Student collections should be done under the guidance of the teacher with attention to the impact on the environment. The number and size of the samples taken for the collections should be considered in light of the educational benefit. Some

organisms should not be taken from the environment, but rather observed and described using photographs, drawings, or written descriptions to be included in the student's collection. Teachers must adhere to the published guidelines for the proper use of animals, equipment, and chemicals in the classroom. These guidelines are available on the Utah Science Home Page.

The Most Important Goal

Science instruction should cultivate and build on students' curiosity and sense of wonder. Effective science instruction engages students in enjoyable learning experiences. Science instruction should be as thrilling an experience for a student as opening a rock and seeing a fossil, determining the quality of a water sample by watching the colors change in a chemical reaction, or observing the consistent sequence of color in a rainbow. Science is not just for those who have traditionally succeeded in the subject, and it is not just for those who will choose science-related careers. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core encourages instruction that provides skills in a context that enables students to experience the joy of doing science.

Earth Science Core Curriculum

Standard 1: Students will understand the scientific evidence that supports theories that explain how the universe and the solar system developed. They will compare Earth to other objects in the solar system.

Objective 1: **Describe both the big bang theory of universe formation and the nebular theory of solar system formation and evidence supporting them.**

a. Identify the scientific evidence for the age of the **solar system** (4.6 billion years), including Earth (e.g., radioactive decay).
b. Describe the **big bang theory** and the evidence that supports this theory (e.g., cosmic background radiation, abundance of elements, distance/redshift relation for galaxies).
c. Describe the **nebular theory** of solar system formation and the evidence supporting it (e.g., solar system structure due to gravity, motion and temperature; composition and age of meteorites; observations of newly forming stars).
d. Explain that **heavy elements** found on Earth are formed in stars.
e. Investigate and report how science has changed the accepted ideas regarding the nature of the universe throughout history.
f. Provide an example of how technology has helped scientists investigate the universe.

Objective 2: **Analyze Earth as part of the solar system, which is part of the Milky Way galaxy.**

a. Relate the **composition** of objects in the solar system to their distance from the Sun.
b. Compare the size of the solar system to the **Milky Way galaxy**.
c. Compare the size and **scale** of objects within the solar system.
d. Evaluate the conditions that currently support life on Earth (**biosphere**) and compare them to the conditions that exist on other planets and moons in the solar system (e.g., atmosphere, hydrosphere, geosphere, amounts of incoming solar energy, habitable zone).

Science language students should use:	Please note that Earth Science terminology has been incorporated into the indicators above and have been bolded and underlined. Students and teachers should integrate these terms into normal daily conversations around science topics.

Standard 2: Students will understand Earth's internal structure and the dynamic nature of the tectonic plates that form its surface.

Objective 1: **Evaluate the source of Earth's internal heat and the evidence of Earth's internal structure.**

a. Identify that **radioactive decay** and **heat of formation** are the sources of Earth's internal heat.
b. Trace the lines of scientific evidence (e.g., seismic studies, composition of meteorites, and samples of the crust and mantle) that led to the inference that Earth's **core**, **mantle**, and **crust** are separated based on **composition**.
c. Trace the lines of scientific evidence that led to the inference that Earth's **lithosphere**, **asthenosphere, mesosphere, outer core,** and **inner core** are separated based on **physical properties**.
d. Model how **convection** currents help distribute heat within the mantle.

Objective 2: **Describe the development of the current theory of plate tectonics and the evidence that supports this theory.**

a. Explain Alfred Wegener's **continental drift hypothesis**, his evidence (e.g., fossil record, ancient climates, geometric fit of continents), and why it was not accepted in his time.
b. Cite examples of how the **geologic record** preserves evidence of past change.
c. Establish the importance of the discovery of **mid-ocean ridges**, **oceanic trenches**, and **magnetic striping** of the sea floor to the development of the modern theory of **plate tectonics**.
d. Explain how **mantle plumes** (hot spots) provide evidence for the rate and direction of tectonic plate motion.
e. Organize and evaluate the evidence for the current theory of plate tectonics: **sea floor spreading**, age of sea floor, distribution of **earthquakes** and **volcanoes**.

Objective 3: Demonstrate how the motion of tectonic plates affects Earth and living things.

a. Describe a **lithospheric plate** and identify the major plates of the Earth.
b. Describe how earthquakes and volcanoes transfer energy from Earth's interior to the surface (e.g., seismic waves transfer mechanical energy, flowing magma transfers heat and mechanical energy).
c. Model the factors that cause **tectonic plates** to move (e.g., gravity, density, convection).
d. Model tectonic plate movement and compare the results of plate movement along **convergent**, **divergent**, and **transform boundaries** (e.g., mountain building, volcanoes, earthquakes, mid-ocean ridges, oceanic trenches).
e. Design, build, and test a model that investigates local geologic processes (e.g., mudslides, earthquakes, flooding, erosion) and the possible effects on human-engineered structures (e.g., dams, homes, bridges, roads).

Science language students should use:	Please note that Earth Science terminology has been incorporated into the indicators above and have been bolded and underlined. Students and teachers should integrate these terms into normal daily conversations around science topics.

Standard 3: Students will understand the atmospheric processes that support life and cause weather and climate.

Objective 1: Relate how energy from the Sun drives atmospheric processes and how atmospheric currents transport matter and transfer energy.

a. Compare and contrast the amount of energy coming from the Sun that is **reflected**, **absorbed** or **scattered** by the **atmosphere**, oceans, and land masses.
b. Construct a model that demonstrates how the **greenhouse effect** contributes to atmospheric energy.
c. Conduct an investigation on how the tilt of Earth's axis causes variations in the intensity and duration of sunlight striking Earth.
d. Explain how uneven heating of Earth's atmosphere at the equator and polar regions combined with the **Coriolis effect** create an atmospheric circulation system including, **Hadley cells**, **trade winds**, and **prevailing westerlies**, that moves heat energy around Earth.
e. Explain how the presence of **ozone** in the **stratosphere** is beneficial to life, while ozone in the **troposphere** is considered an **air pollutant**.

Objective 2: Describe elements of weather and the factors that cause them to vary from day to day.

a. Identify the elements of **weather** and the instruments used to measure them (e.g., temperature—thermometer; precipitation—rain gauge or Doppler radar; humidity—hygrometer; air pressure—barometer; wind—anemometer; cloud coverage—satellite imaging).
b. Describe conditions that give rise to severe weather phenomena (e.g., thunderstorms, tornados, hurricanes, El Niño/La Niña).
c. Explain a difference between a **low pressure system** and a **high pressure system**, including the weather associated with them.
d. Diagram and describe **cold**, **warm**, **occluded**, and **stationary boundaries** (weather fronts) between **air masses**.
e. Design and conduct a weather investigation, use an appropriate display of the data, and interpret the observations and data.

Objective 3: Examine the natural and human-caused processes that cause Earth's climate to change over intervals of time ranging from decades to millennia.

a. Explain differences between **weather** and **climate** and the methods used to investigate evidence for changes in climate (e.g., ice core sampling, tree rings, historical temperature measurements, changes in the extent of alpine glaciers, changes in the extent of Arctic sea ice).
b. Explain how Earth's climate has changed over time and describe the natural causes for these changes (e.g., Milankovitch cycles, solar fluctuations, plate tectonics).
c. Describe how human activity influences the **carbon cycle** and may contribute to climate change.
d. Explain the differences between air pollution and climate change and how these are related to society's use of **fossil fuels**.

e. Investigate the current and potential consequences of **<u>climate change</u>** (e.g., ocean acidification, sea level rise, desertification, habitat loss) on **<u>ecosystems</u>**, including human communities.

Science language students should use:	Please note that Earth Science terminology has been incorporated into the indicators above and have been bolded and underlined. Students and teachers should integrate these terms into normal daily conversations around science topics.

Standard 4: Students will understand the dynamics of the hydrosphere.

Objective 1: Characterize the water cycle in terms of its reservoirs, water movement among reservoirs and how water has been recycled throughout time.

a. Identify oceans, lakes, running water, frozen water, ground water, and atmospheric moisture as the **reservoirs** of Earth's **water cycle**, and graph or chart the relative amounts of water in each.
b. Describe how the processes of **evaporation**, **condensation**, **precipitation**, **surface runoff**, **ground infiltration** and **transpiration** contribute to the cycling of water through Earth's reservoirs.
c. Model the **natural purification** of water as it moves through the water cycle and compare natural purification to processes used in local sewage treatment plants.

Objective 2: Analyze the characteristics and importance of freshwater found on Earth's surface and its effect on living systems.

a. Investigate the properties of water: exists in all three states, dissolves many substances, exhibits **adhesion** and **cohesion**, density of solid vs. liquid water.
b. Plan and conduct an experiment to investigate **biotic** and **abiotic** factors that affect freshwater **ecosystems**.
c. Using data collected from local water systems, evaluate water quality and conclude how pollution can make water unavailable or unsuitable for life.
d. Research and report how communities manage water resources (e.g., distribution, shortages, quality, flood control) to address **social**, **economic**, and **environmental** concerns.

Objective 3: Analyze the physical, chemical, and biological dynamics of the oceans and the flow of energy through the oceans.

a. Research how the oceans formed from **outgassing** by **volcanoes** and ice from **comets**.
b. Investigate how **salinity**, temperature, and pressure at different depths and locations in oceans and lakes affect saltwater ecosystems.
c. Design and conduct an experiment comparing **chemical properties** (e.g., chemical composition, percent salinity) and **physical properties** (e.g., density, freezing point depression) of freshwater samples to saltwater samples from different sources.
d. Model **energy flow** in the physical dynamics of oceans (e.g., wave action, deep ocean tides circulation, surface currents, land and sea breezes, El Niño, upwellings).
e. Evaluate the impact of human activities (e.g., sediment, pollution, overfishing) on ocean systems.

Science language students should use:	Please note that Earth Science terminology has been incorporated into the indicators above and have been bolded and underlined. Students and teachers should integrate these terms into normal daily conversations around science topics.

Standard 5: Students will understand how Earth science interacts with society.

Objective 1: Characterize Earth as a changing and complex system of interacting spheres.

a. Illustrate how energy flowing and matter cycling within Earth's **biosphere**, **geosphere**, **atmosphere**, and **hydrosphere** give rise to processes that shape Earth.
b. Explain how Earth's systems are dynamic and continually react to natural and human-caused changes.
c. Explain how technological advances lead to increased human knowledge (e.g., satellite imaging, deep sea ocean probes, seismic sensors, weather radar systems) and ability to predict how changes affect Earth's systems.
d. Design and conduct an experiment that investigates how Earth's **biosphere**, **geosphere**, **atmosphere**, or **hydrosphere** reacts to human-caused change.
e. Research and report on how scientists study **feedback loops** to inform the public about Earth's interacting systems.

Objective 2: Describe how humans depend on Earth's resources.

a. Investigate how Earth's resources (e.g., mineral resources, petroleum resources, alternative energy resources, water resources, soil and agricultural resources) are distributed across the state, the country, and the world.
b. Research and report on how human populations depend on **Earth resources** for sustenance and how changing conditions over time have affected these resources (e.g., water pollution, air pollution, increases in population).
c. Predict how resource development and use alters Earth systems (e.g., water reservoirs, alternative energy sources, wildlife preserves).
d. Describe the role of scientists in providing data that informs the discussion of Earth resource use.
e. Justify the claim that **Earth science literacy** can help the public make informed choices related to the extraction and use of natural resources.

Objective 3: Indicate how natural hazards pose risks to humans.

a. Identify and describe **natural hazards** that occur locally (e.g., wildfires, landslides, earthquakes, floods, drought) and globally (e.g., volcanoes, tsunamis, hurricanes).
b. Evaluate and give examples of human activities that can contribute to the frequency and intensity of some natural hazards (e.g., construction that may increase erosion, human causes of wildfires, climate change).
c. Document how scientists use technology to continually improve estimates of when and where natural hazards occur.
d. Investigate and report how **social**, **economic**, and **environmental** issues affect decisions about human-engineered structures (e.g., dams, homes, bridges, roads).

Science language students should use:	Please note that Earth Science terminology has been incorporated into the indicators above and have been bolded and underlined. Students and teachers should integrate these terms into normal daily conversations around science topics.