5TH GRADE-8TH GRADE

Earth and Space Science

Content Standard D:

As a result of the activities in grades 5-8, all students should develop an understanding of

- **Structure of the earth system**
- **Earth's history**
- **Earth in the solar system**

Content Summary

National Science Education Content Standards

K-4

Properties of earth materials

Objects in the sky

Changes in earth and sky

5-8

Structure of the earth systems

Earth's history

Earth in the solar system

9-12

Energy in the earth system

Geochemical cycles

Origin and evolution of the earth system

Origin and evolution of the universe

Minnesota Graduation Standards

Primary Level

Direct Science Experience:

Understand basic science concepts through direct experience

Intermediate Level

Living and Non-living Systems:

Understand how individuals and objects interact in life, earth/space systems and physical systems

Middle Level

Earth Systems:

Recognize concepts and evaluate interactions of earth/space systems and the impact upon human life

High School Level

Earth and Space Systems:

Understand concepts, theories and principles of earth and space systems through investigation and analysis

Focus K-12

Grade	Early	Late
K-4	The focus of instruction early in this grade range is on providing opportunities for all students to observe earth materials, their properties, and how they change over time.	The focus of instruction later in this grade range is on providing opportunities for all students to observe and describe objects in the sky and changes in the earth and sky as they identify sequences, look for patterns, and develop possible explanations of phenomena in the earth system.
5-8	The focus of instruction for all students early in this grade range is on developing a basic understanding of the components of the earth system and the movement of objects in the solar system.	The focus of instruction for all students later in this grade range is on developing an understanding of the dynamic nature of the earth system, its evolution, and its relationship to the solar system.
9-12	The focus of instruction in earth and space science at the high school level is on providing all students an opportunity to develop an understanding of the role of cycles in structuring the earth system, the use of evidence to develop an understanding of deep space and deep time, and apply their understandings in a variety of situations.	The focus of instruction for students pursuing further study in earth/space science is on increasing students' knowledge and understanding of the origin and evolution of the earth system and the universe and apply their understandings in a variety of situations.

Close-up 5-8

The focus of instruction for all students early in this grade range is on developing a basic understanding of the components of the earth system and the movement of objects in the solar system.

As an introduction to the earth's physical and chemical cycles, students investigate the water and rock cycles. They study the composition of the earth system by exploring the physical characteristics of rocks, minerals, and soils. Teacher-directed activities engage students in determining the characteristics of soils, weathering, and the action of streams and rivers on materials. Ideas about the earth's history are introduced through exploration of fossils and geological field sites. The study of astronomy concepts at the intermediate grades should emphasize the behavior of objects in the solar system that are visible from earth. The students' study centers on direct observations of the day and night sky, and tracking moon phases, day length, and the changing seasons. Students and teachers observe established science safety procedures.

The focus of instruction for all students later in this grade range is on developing an understanding of the dynamic nature of the earth system, its evolution, and its relationship to the solar system.

All students investigate the four major interacting components of the earth system — geosphere (crust, mantle, and core), hydrosphere (water), atmosphere (air), and the biosphere (the realm of all living things.) They study the geosphere by comparing soils from different ecosystems. Students map areas around their schools and build and use models to investigate land forms, streams, and ground water. They examine the properties of rocks, minerals, and fossils and relate them to the history of their formation. Students examine evidence of changes in the distribution of land and sea, the composition of the earth's atmosphere, and the distribution of living organisms. They investigate the behavior of the atmosphere by collecting local weather data and relating the trends to national and global weather systems. Scale models and visual representations of planets and the solar system are used to explore the relationship of the earth within the solar system, although many students will not fully understand this relationship. Students and teachers observe established science safety procedures.

On Location 5-8

This vignette illustrates students learning about the stories that properties of rocks and sediments tell us about the earth. Important knowledge gained includes awareness of different types of sediment or rocks in different natural environments. Important science skills practiced include sample collecting, observation and recording, experimentation, interpretation of observations and experiments, and use of past interpretations to reach new conclusions. The vignette illustrates a variety of teaching techniques allowing students to learn from their own activity, learn from hearing and discussion, and learn through observation.

As part of an extensive study of their natural environment, Mr. B's students spend time learning about connections between sediment, rocks, and the environment, and thinking about how environments have changed in the past. Each student brings one or two samples of sediment ("dirt") to class, taking care to describe exactly the location where they collected his/her sample. Students involve their families or other adults in the collection of sediment as they explore streams, ponds, lake shores, lake bottoms, bogs or marshes, steep hills, flat fields, or other environments near their home.

They are told to avoid places that contain indistinct sediments, such as their yard, or places that are not related to the natural environment, such as a sandbox. Students describe each sample, recording its appearance, odor, texture, and any characteristics they notice such as sand (How big are the particles?) or remains of living things (What kinds of living things?). They record their observations with pictures and words, taking care to label each description. Students then use their records in an "identification game" in which each team tries to recognize sediments after they have been scrambled, using only their memories and their records of each sample.

Later, after students have become comfortable with how the samples are different, they begin to think about why they are different. Students talk about and try to determine the environments different samples come from. After discussion, students work in groups to construct a lake and lake shore in a plastic basin, using a mixture of fine dirt, sand, and gravel.

They use their hand to make small waves that lap against the shoreline and record their observations: how the slope of the sand changes at the shoreline, where the shoreline is steeper, where it is less steep, and the way sediment is accumulated and distributed at the shoreline and further out in the lake over time. They speculate on how the different parts of the original sediment become separated.

After the students have become familiar with sediments, Mr. B distributes samples of a fossil trilobite in shale and a fossil worm burrow in sandstone. Students are helped to see that the sandstone is made of little sand grains stuck together. Scraping the shale with a knife, Mr. B shows them the fine powder that results and the students describe it as a rock made of mud. Since the students studied insects in an earlier science activity, Mr. B has them draw pictures of the trilobite and describe to each other how it is like an insect and how it is different from an insect. Then the students draw a picture of the trilobite in the environment in which it died, including other animals, plants, or features that they think may have been there. What kind of place was it? Was it a beach? A river? They also draw a picture of the environment where the worm which made the burrow lived. Was it in the same place as the trilobite? Could it have been close by?

Structure of the Earth System

- The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.
- Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.
- Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
- Some changes in the solid earth can be described as the "rock cycle." Old rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.
- Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.
- Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
- Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans.
- The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.
- Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.

Earth's History

- The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.
- Fossils provide important evidence of how life and environmental conditions have changed.

Earth in the Solar System

- The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system.
- Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.
- Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides.
- The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.

Minnesota Graduation Standards

Intermediate Level

Living and Non-Living Systems:

Understand how individuals and objects interact in life, earth/space systems, and physical systems.

What students should know:

1. Understand characteristics of organisms:
   a. plants
   b. animals
   c. micro-organisms
2. Understand basic structures and functions of the human body
3. Understand cycles and patterns in:
   a. living organisms
   b. earth systems
   c. physical systems
4. Understand how human behavior and technology impact the environment
5. Understand characteristics of the physical world (e.g., land forms, solar system, electro-magnetism, chemical reactions)

What students should do:

1. Measure and classify objects, organisms, and materials on the basis of their properties and relationships
2. Make systematic observations of objects, events and/or phenomena:
   a. record data
   b. predict change
3. Create a model to illustrate a concept, law, theory or principle
4. Identify personal behaviors and use of materials which have a positive impact on the environment

In Addition:

1. Performance packages should include tasks which address earth, life and physical science.
2. Whenever possible this standard should be combined with the Inquiry standard.
3. Tasks should be related to students' environment.
4. Students must demonstrate basic safety procedures and skills when using tools and equipment.

Minnesota Graduation Standards

Middle Level

Earth Systems:

Recognize concepts and evaluate interactions of earth/space systems and the impact upon human life.

What students should know:

1. Understand the structure of earth systems including:
   a. geosphere (e.g., plate tectonics, volcanoes, earthquakes, earth layers, soil development)
   b. hydrosphere (e.g., water cycle, erosion, water bodies)
   c. atmosphere (e.g., weather, climate)
2. Understand concepts of change and constancy in the Earth's history and theories of origin through evidence found in:
   a. fossils
   b. rocks and layers
   c. land forms
   d. natural events (e.g., volcanic eruptions, meteorites)
3. Understand the relative position and motion of objects in the solar system:
   a. moon phases, tides
   b. seasons
   c. eclipses
   d. gravitational force
   e. planetary motion

What students should do:

1. Formulate questions to be answered based on systematic observations
2. Design and conduct investigations and field studies
3. Analyze data to support or refute hypotheses:
   a. identify patterns in data
   b. compare results to known scientific theories, current models and/or personal experience
   c. consider multiple interpretations of data
4. Describe how a premise (e.g., medical procedure, invention, claim) is supported by scientific concepts, principles, theories or laws
5. Create a model to illustrate a contemporary or historical concept, principle, theory or law

In Addition:

1. Students should work with teacher guidance.
2. This standard should be paired with an Inquiry standard whenever appropriate.
3. When possible, students should be given opportunities to work in earth systems from the local region.
4. Students must demonstrate basic safety procedures and skills when using tools and equipment.
5. Tasks should address environmental concerns whenever appropriate.