Sixth Grade Companion Document

6-Unit 4: Plate Tectonics and Fossils

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Introduction to the K-7 Companion Document
An Instructional Framework

Overview

The Michigan K-7 Grade Level Content Expectations for Science establish what every student is expected to know and be able to do by the end of Grade Seven as mandated by the legislation in the State of Michigan. The Science Content Expectations Documents have raised the bar for our students, teachers and educational systems.

In an effort to support these standards and help our elementary and middle school teachers develop rigorous and relevant curricula to assist students in mastery, the Michigan Science Leadership Academy, in collaboration with the Michigan Mathematics and Science Center Network and the Michigan Science Teachers Association, worked in partnership with Michigan Department of Education to develop these companion documents. Our goal is for each student to master the science content expectations as outlined in each grade level of the K-7 Grade Level Content Expectations.

This instructional framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings and expanding thinking beyond the classroom.

These companion documents are an effort to clarify and support the K-7 Science Content Expectations. Each grade level has been organized into four teachable units- organized around the big ideas and conceptual themes in earth, life and physical science. . The document is similar in format to the Science Assessment and Item Specifications for the 2009 National Assessment for Education Progress (NAEP). The companion documents are intended to provide boundaries to the content expectations. These boundaries are presented as “notes to teachers”, not comprehensive descriptions of the full range of science content; they do not stand alone, but rather, work in conjunction with the content expectations. The boundaries use seven categories of parameters:

a. **Clarifications** refer to the restatement of the “key idea” or specific intent or elaboration of the content statements. They are not intended to denote a sense of content priority. The clarifications guide assessment.
b. **Vocabulary** refers to the vocabulary for use and application of the science topics and principles that appear in the content statements and expectations. The terms in this section along with those presented within the standard, content statement and content expectation comprise the assessable vocabulary.

c. **Instruments, Measurements and Representations** refer to the instruments students are expected to use and the level of precision expected to measure, classify and interpret phenomena or measurement. This section contains assessable information.
d. **Inquiry Instructional Examples** presented to assist the student in becoming engaged in the study of science through their natural curiosity in the subject matter that is of high interest. Students explore and begin to form ideas and try to make sense of the world around them. Students are guided in the process of scientific inquiry through purposeful observations, investigations and demonstrating understanding through a variety of experiences. Students observe, classify, predict, measure and identify and control variables while doing "hands-on" activities.
e. **Assessment Examples** are presented to help clarify how the teacher can conduct formative assessments in the classroom to assess student progress and understanding
f. **Enrichment and Intervention** is instructional examples the stretch the thinking beyond the instructional examples and provides ideas for reinforcement of challenging concepts.
g. **Examples, Observations, Phenomena** are included as exemplars of different modes of instruction appropriate to the unit in which they are listed. These examples include reflection, a link to real world application, and elaboration beyond the classroom. These examples are intended for instructional guidance only and are not assessable.
h. **Curricular Connections and Integrations** are offered to assist the teacher and curriculum administrator in aligning the science curriculum with other areas of the school curriculum. Ideas are presented that will assist the classroom instructor in making appropriate connections of science with other aspects of the total curriculum.

This Instructional Framework is NOT a step-by-step instructional manual but a guide developed to help teachers and curriculum developers design their own lesson plans, select useful portions of text, and create assessments that are aligned with the grade level science curriculum for the State of Michigan. It is not intended to be a curriculum, but ideas and suggestions for generating and implementing high quality K-7 instruction and inquiry activities to assist the classroom teacher in implementing these science content expectations in the classroom.

6th Grade Unit 3:
Composition, Properties, and Changes of the Earth

Content Statements and Expectations

6 – Unit 4: Plate Tectonics and Fossils

Big Ideas (Key Concepts)

- The surface of the Earth undergoes gradual and rapid changes.
- Plate tectonics is the central organizing theory of the field of geology and explains major landforms and geologic events.

Clarification of Content Expectations

Standard: Solid Earth

Content Statement – E.SE.M.5

Plate Tectonics – The lithospheric plates of the Earth constantly move, resulting in major geological events, such as earthquakes, volcanic eruptions, and mountain building.

Content Expectations

E.SE.06.51 Explain plate tectonic movement and that the lithospheric plates move centimeters each year.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally the movement of lithospheric plates.
2. The Earth's crust is composed of seven major semi-rigid plates that slowly move in various directions. The plates are referred to as lithospheric plates.
3. These plates only move centimeters per year.
4. One theory for the movement of the plates is that the mantle pushes the plates by a process called convection. When a gas or a liquid is heated unevenly, the part that is heated rises (convection current).
5. Another theory is that gravity pulls the old heavier ocean floor with more force then the newer lighter seafloor.
6. As the plates move they interact with one another at their boundaries – where they are separating, converging, or sliding past each other.

Assessment Clarifications

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6. As the plates move they interact with one another at their boundaries – where they are separating, converging, or sliding past each other.

E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.

Instructional Clarifications

1. Demonstrate is to show major geological events through manipulation of materials, drawings, and written and verbal explanations.
2. Earthquakes are formed when the boundaries of the lithospheric plates move against each other, building up pressure, then cause a sudden and often violent shift. This movement causes an earthquake.
3. Volcanoes are formed when plates move apart or collide.
4. When two plates collide, one plate is pushed up and the other slides under. Part of the crust that slides under is melted and forms magma and can be forced through vents to form volcanic mountains.
5. Volcanoes can also be formed when a plate moves over a hot spot in the mantle and exposes a vent. Fountains of magma or hot rock punch through the crust.
6. When plates beneath the ocean move apart a vent is exposed and magma slowly rises to the surface, which forms a new ocean floor.
7. Mountains form when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of the Earth's crust.

Assessment Clarifications

1. Earthquakes are formed when the boundaries of the lithospheric plates move against each other, building up pressure, and then causing a sudden and often violent shift. This movement causes an earthquake.
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E.SE.06.53 Describe layers of the Earth as lithosphere (crust and upper mantle) convecting mantle, and a dense metallic core.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words the layers of the Earth.
2. Lithosphere is the solid, most outer part of the Earth; the part of the Earth's surface that is made up of land, including the ocean's floor.
3. The earth's crust is the outside (exterior) of the Earth.
4. Mantle is the layer of the Earth between the crust and the core.
5. The core of the Earth is found below the mantle.
6. The core of the Earth is made up of iron and nickel.
7. There is a liquid outer core and a solid inner core.
8. The core of the Earth heats the mantle. This transfer of energy through the layers of the Earth is convection.

Assessment Clarifications

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Content Statement – E.ST.M.3

Fossils – Fossils provide important evidence of how life and environmental conditions have changed in a given location.

Content Expectation

E.ST.06.31 Explain how rocks and fossils are used to understand the age and geological history of the Earth (timelines and relative dating, rock layers).

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports, or verbally how rocks and fossils are used to understand the age and geological history of the Earth.
2. The Earth has distinct layers of rock.
3. Sedimentary rocks most often contain fossils.
4. The rock layers show a progression of organisms from layer to layer.
5. Relative dating can be used to estimate the order of prehistoric and geological events.
6. This happens by observing where fossils are found in layers of rock.
7. Timelines describe the timing and relationships between events in the Earth's history.
8. The Earth is estimated to be about 4.5 billion years old.

Assessment Clarifications

1. The Earth has distinct layers of rock.
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Content Statement – E.ST.M.4

Geologic Time – Earth processes seen today (erosion, mountain building, and glacier movement) make possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations.

Content Expectations

E.ST.06.41 Explain how Earth Processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how erosion, mountain building and glacier movement are used for the measurement of geologic time through observing rock layers.
2. Erosion is the wearing away of material through wind and water. The process of erosion can expose layers of rock.
3. Mountain building is when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of Earth's crust. Mountain building changes the shape of the Earth.
4. Over time all mountains will crumble through erosion.
5. Mountain peaks eventually become rounded hills.
6. The observation and study of rock layers is used for the measurement of geologic time.
7. Glaciers are slow moving masses of ice formed from compacted layers of snow. Glaciers move and change with temperature change, gravity, and high pressure.
8. Glaciers carve out mountains.
9. Glaciers move rocks out of mountains.
10. Erosion, mountain building, and glacier movement change the surface of the earth and earth materials to from layers. Rock layers are used to show the geologic time and history of the Earth.

Assessment Clarifications

1. Erosion is the wearing away of material through wind and water. The process of erosion can expose layers of rock.

2. Mountain building is when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of Earth's crust. Mountain building changes the shape of the Earth.
3. Glaciers are slow moving masses of ice formed from compacted layers of snow. Glaciers move and change with temperature change, gravity, and high pressure.
4. Erosion, mountain building, and glacier movement change the surface of the earth and earth materials to from layers. Rock layers are used to show the geologic time and history of the Earth.

E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.

Instructional Clarifications

1. A fossil is an imprint, replacement, or remains of an organism from ancient times.
2. Fossils provide a historical perspective on change of the Earth.
3. Fossils provide a biological record of life on Earth.
4. Fossils provide a record of how organisms have changed over time.
5. The fossil record can be aligned to the major environmental changes that have occurred on Earth.
6. The fossil record provides evidence from a "living laboratory."
7. The fossil record illustrates how organisms responded to environmental change.
8. Some fossils provide a continuous record of environmental change.

Assessment Clarifications

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Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications

Inquiry Processes
S.IP.06.11 Generate scientific questions based on observations, investigations, and research about the plate tectonic movement.
S.IP.06.12 Design and conduct scientific investigations into erosion, mountain building, and glacier movement.
S.IP.06.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, sieves, microscopes) appropriate for observations and scientific investigations into earthquakes, volcanoes, and mountain building.
S.IP.06.14 Use metric measurement devices in model building for investigations into major geological events.
S.IP.06.15 Construct charts and graphs from data and observations of models of geological events, fossils, and erosion.
S.IP.06.16 Identify patterns in data.
Inquiry Analysis and Communication
S.IA.06.11 Analyze information from data tables and graphs to answer questions about the formation of volcanoes, mountains, and earths processes.
S.IA.06.12 Evaluate data, claims, and personal knowledge through collaborative science discourse about the theory of tectonic plates and the importance of evidence through fossils.
S.IA.06.13 Communicate and defend findings of observations and investigations into major geological events and Earth processes using evidence.
S.IA.06.14 Draw conclusions from sets of data from multiple trials of scientific investigation of major geological events and Earth processes.
S.IA.06.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data regarding plate tectonics and the evidence provided by fossils.
Reflection and Social Implications
S.RS.06.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding plate tectonics and the evidence provided by fossils.
S.RS.06.12 Describe limitations in personal and scientific knowledge regarding plate tectonics and the history of the Earth.
S.RS.06.13 Identify the need for evidence in making scientific decisions.
S.RS.06.14 Evaluate scientific explanations based on current evidence and plate tectonics and evidence from fossils.
S.RS.06.15 Demonstrate plate movement, formation of mountains and volcanoes, and the occurrence of earthquakes through various illustrations, models, exhibits, and activities.
S.RS.06.16 Design solutions to problems using technology.
S.RS.06.18 Describe what science and technology can and cannot reasonably contribute to the study of major geological events and determining the history of the Earth.
S.RS.06.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
plate tectonic lithospheric plates geological events earthquakes volcanic eruptions mountain building lithosphere crust upper mantle, convecting mantle, metallic core fossils rocks geological history timelines relative dating, rock layers earth processes erosion glacier movement environmental conditions	Pangea Richtor scale lava magma tremor vibrations weathering wind water movement Seizmograph Magnitude

Instruments, Measurements, Representations

The study of plate tectonics, fossils, and rock layers presents the opportunity for students to learn about the use of evidence, inference, and making models to explain phenomena that cannot be observed in the present or on Earth. The use of models for representation of plate movement, rock layers, and how fossils are made provide a glimpse of the past.

Fossil identification and comparison to modern life forms requires the use of the hand lens, measurement in millimeters, and representations through drawing and models.

Research and analysis of data, theories, and representations made by other scientists is an important form of information gathering when trying to uncover Earth's history and relate modern life forms, climate, and the shape of the Earth to cycles that take millions of years to complete.

Instructional Framework

The following Instructional Framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings, and expanding thinking beyond the classroom. The Instructional Framework is NOT a step-by-step instructional manual, but a guide intended to help teachers and curriculum developers design their own lesson plans, select useful and appropriate resources and create assessments that are aligned with the grade level science curriculum for the State of Michigan.

Instructional Examples

Plate Tectonics: E.SE.06.51, E.SE.06.52, E.SE.06.53
Fossils: E.ST.06.31,
Geologic Time: E.ST.06.41, E.ST.06.42

Objectives

- Use models to explain major geological events, plate tectonics, and layers of the Earth.
- Make observations of rock layers and fossils and compare them to modern life forms to demonstrate environmental change over time.

Engage and Explore

- Use a classroom globe and have students find the oceans and continents that make up Earth today. (E.SE.06.51)
- Display a map of the Earth that shows the oceans and continents. Explain how the map represents Earth as a sphere. Divide the class into teams of two and have the students distribute one map of Earth and have them cut out the continents and oceans, mix them up and try to put the world back together again. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15)
- Ask the students to closely examine the coastline of the continents. Bring their attention to the eastern coastline of South America and the western coastline of Africa. Explain that some scientists believe that the continents once were joined in a single landmass. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15)
- Provide research material for students to read about the scientists Alfred Wegener and Sir Francis Bacon and the theory of continental drift. In their research, ask students to look for the evidence each scientist used to explain his theory and some of the skepticism from other scientists. Compare Wegener's and Bacon's theories with what scientists believe today. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15, S.RS.06.19)

- Have the students recreate the evidence used by the scientists to support their theories. Create game cards that give examples of fossils of plants and animals that were discovered on continents now separated by oceans. For example, the fossils of fresh water reptiles Mesosaurus and Lystrosaurus were discovered on South America and Africa. These animals are not capable of swimming an ocean. The imprint fossil of the plant Glossopteris have been found in rocks in Africa, South America, Australia, India, and Antarctica. Have the students match the fossil to the different continents where they had been discovered. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15)
- Simulate rock layers and fossils that are found within rock layers using a model. Place 3 different colors of aquarium gravel in separate baggies. Mix 1/4 cup sand and 1/4 cup soil into each bag. Shake the gravel/soil mixtures to thoroughly mix the materials. Fill a clear container 1/2 full with water. Use a spoon to slowly sprinkle the gravel/soil mixture from one of the baggies into the water. Wait 10 minutes and observe. Repeat the process with the two remaining baggies every 10 minutes. To simulate fossils, add a small plastic animal or plant. Discuss the age of the bottom layer compared to the top layer. Ask students how major events affect rock layers. Explain that each 10 minutes represents thousands to millions of years. Discuss what might happen if plant or animal remains were trapped between the layers. (E.ST.06.31, S.IP.06.11, S.IA.06.12, S.IA.06.13, S.RS.06.11, S.RS.06.12, S.RS.06.14)

Explain and Define

- Using maps, textbooks, and the Internet, have students find the seven major semi-rigid sections or plates called the lithospheric plates that move in various directions. (E.SE.06.51, S.IA.06.15)
- Have students make models of the plates and demonstrate the different types of movements of the plates as they collide, pull apart, or grind past each other, producing changes in Earth's surface. Have students include plate boundaries in their models (divergent boundaries, convergent boundaries, and transform boundaries). (E.SE.06.51, E.SE.06.52, S.IP.06.13, S.IA.06.12, S.IA.06.13, S.IA.06.15, S.RS.06.11, S.RS.06.14)
- Explain that Earth material mixture in the rock layer models represent Earth deposits from erosion over long periods of time. Great pressure and heat over long periods of time eventually turn the layers to rock. Discuss how fossils found in the different layers give evidence of organisms and climate from long ago. (E.ST.06.31, E.ST.06.41, E.ST.06.42)

Elaborate and Apply

- Using their models, students explain how the plate motion results in earthquakes, volcanic eruptions, and mountain building. (E.SE.06.52, S.IP.06.13, S.IA.06.11, S.RS.06.14, S.RS.06.15)
- Elaborate further on the history of the Earth by researching Earth's different layers (crust and upper mantle, convecting mantle and dense metallic core). (E.SE.06.53, S.IA.06.15, S.RS.06.11, S.RS.06.14, S.RS.06.15)

- Make an edible model of rock layers that simulates the movement and folding and faulting of rock strata like sandstone, siltstone, limestone, and shale. (Different food layers represent the different rock strata, gram cracker crumbs, gelatin, pudding, and Oreo cookie crumbs. Pieces of fruit represent fossils found in different layers.) (E.ST.06.31, S.RS.06.15)
- Conduct a mock fossil dig by planting different items to represent fossils between different layers of gravel, sand, soil, etc. Have students explain how the organism lived a very long time ago and the fossils found in the layers far below the Earth's surface lived the longest time ago. (E.ST.06.13, E.ST.06.42, S.RS.06.15, S.RS.06.13)

Evaluate Student Understanding

Formative assessment

- Use the student presentations, models and discussion to assess the students' ability to describe plate tectonics and the theory of moving plates.
- Use the class discussions and student presentations to assess their ability to identify the need for evidence.
- Use student research and presentations to assess their ability to use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

Summative Assessment

- Students describe how scientists use rock layers and fossils found within the layers to describe the geological history of the Earth.
- Models are used to assess students on their ability to explain mountain building, earthquakes, and volcanic eruptions.
- Student research papers and presentations are used to assess their understanding of plate tectonics and how scientists use evidence to establish theories.

Enrichment

- Students can further explore fossils by researching plants and animals that lived long ago and comparing them to modern plants and animals.
- Students research the most recent volcanic eruptions and earthquakes and make models of structures that can withstand catastrophic events.

Intervention

- Students make models of earthquakes and demonstrate the destruction of earthquakes and other catastrophic events.
- Students explore different materials that are used to make strong structures that will withstand an earthquake.

Examples, Observations, and Phenomena (Real World Context)

The evidence of the history of the Earth is ongoing. Geological digs are providing fossils that give evidence of once living things and ancient climates. The continued study of the Earth provides students with real world news and articles that explain how the history of the Earth relates to problems faced on Earth today.

The digging out of hillsides and mountainsides to clear the way for highways and other excavation projects, provide a glimpse at rock layers that were formed thousands and millions of years ago.

The comparison of ancient life forms through fossils and modern life forms give evidence of cycles and patterns in climate, terrain, and living things.

Literacy Integration

Reading

R.IT.06.01 analyze the structure, elements, features, style, and purpose of information genre, including research reports, “how-to” articles, and essays.

R.IT.06.03 explain how authors use text features including footnotes, bibliographies, introductions, summaries, conclusions, and appendices to enhance the understanding of central, key and supporting ideas.

R.CM.06.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.06.03 analyze global themes, universal truths and principles within and across texts to create a deeper understanding by drawing conclusions, making inferences, and synthesizing.

R.CM.06.04 apply significant knowledge from grade-level science, social studies, and mathematical texts.

Writing

W.GN.06.03 formulate research questions using multiple resources and perspectives that allow them to organize, analyze, and explore problems and pose solutions that culminate in a final presented project using the writing process.

W.PR.06.02 apply a variety of pre-writing strategies for both narrative and informational writing.

Mathematics Integration

N.FL.06.10 Add, subtract, multiply and divide positive rational numbers fluently.

- The exploration and research into the history of the Earth provides the opportunity for students to mathematically investigate millions of years and determine the period as compared to the present.