Blueprint for Instruction: Earth and Space Science

133 class = 27 weeks of instruction.

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TXESS Revolution Themes

This blueprint for high school Earth and Space science is designed to serve as a coherent framework for teachers to follow as they teach a one-year course (approximately 30 weeks). It is organized on twelve large themes in earth system science that were presented in the NSF-sponsored TeXas Earth and Space Science (TXESS) Revolution teacher professional development program. The blueprint does not attempt to cover all of Earth and Space Science, but rather it takes an in-depth look at some key topics that are critical for understanding the challenges that humans face in living on this "restless planet." Although each chapter in this blueprint looks at a different aspect of earth science, all of them emphasize the interconnections among the lithosphere, atmosphere, hydrosphere, cryosphere, and biosphere and the dynamic nature of our planet. Other overarching themes are the nature of science as practiced by contemporary earth scientists, the intellectual processes essential to science such as inquiry and the use of data in drawing conclusions, the depth of geologic time, and the usefulness of earth science in solving environmental challenges, addressing our need for resources and coping with geohazards.

We begin with Earth's place in the solar system and the elements that make it uniquely supportive of life. Then we consider Earth as a system of systems in Chapter 2. Next we introduce plate tectonics, the unifying paradigm of understanding geologic processes, followed by a chapter on seismology. Next is geologic time, in which the basic principles of geology are discovered, and students begin to understand the depth of geologic time. Chapter 6 focuses on how we study Earth, both at the surface and deeper, through large multi-institutional and often multi-national collaborative programs that depend on advanced technology. Water, a critical resource, is the focus of chapter 7, followed by a chapter that examines the frozen water found on Earth's surface (cryosphere) and its role in global climate. Life on Earth depends on, is shaped by, and affects climate. Chapter 9 delves more deeply into understanding Earth's climate system and how climate varies over space and time through both natural processes and human activities. Chapter 10 considers energy and resources, and the connection to climate. Chapter 11 examines extreme events and introduces learners to one of the most extreme environments on Earth, the mid-ocean ridge system where exotic organisms flourish in the hot chemical plumes of black and white smokers. The course finishes with questions of human/earth interaction and sustainability.

COURSE KEY

ESS = Earth and Space Science

TXESS Revolution Chapter 1: Earth the Habitable Planet. We sit on this "third rock from the sun" in an enviable position, exactly the right size and distance from the sun so that water exists on this planet in all three of its natural states. Without solid, liquid, and gaseous forms of water, life as we know it would not be possible on Earth. This chapter sets the stage for the study of Earth as a system of systems by examining Earth's place in the solar system, and some of the physical processes that make Earth a habitable planet.

Time: **10** 50-minute class period (about 2 weeks)

Learning Objectives
Students will know

- The bodies of the solar system
- How the solar system formed
- Qualities of the planet Earth
- How Earth's magnetic field is formed and why it is important
- How volcanoes contributed to the formation of the solid Earth and its atmosphere
- How the earth system as a whole works
- How Earth's solid, liquid, and gas layers work together to support life

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
The Planetary Bodies of Our Solar System **http://txessrevolution.org/PlanetaryGenInfo** Groups of students work together to gather information on planetary bodies, and then the class debates which planetary body would be the best to visit as a tourist. Adapted by Katherine Ellins from "The Great Planetary Debate" (http://www.windows2universe.org/teacher_resources/planetary_debate_edu.html&lang=en), by Jennifer Bergman, available at Windows to the Universe.	Interactive Instruction: Debate. Learners work cooperatively to conduct research, and practice communication and listening skills. Use of computers for web-based research.	ESS: 5D,E ES Literacy Principles: 2.2, 2.3, 2.4, 2.5	5 (50-minute) class periods
Earth's Magnetic Field and the Sun-Earth Connection **http://txessrevolution.org/MagneticSun_Intro** This three-part activity explores magnetic fields and asks students to apply that newfound knowledge to explore Earth's magnetic and how it keeps the planet habitable. Developed and adapted by Hilary Olson	Direct teaching using video-based instruction, guided inquiry (3 hands-on investigations) and model building.	ESS: 9C, D ES Literacy Principles: 1.4, 1.6	4 (50-minute) class periods
Making an Earth: The Role of Volcanoes Students explore various aspects and types of volcanoes to learn about the importance of volcanism in the formation of the early Earth and development of geologic features on Earth. Developed by Katherine Ellins	Guided inquiry with use of computer. Cooperative or individual research.	ESS: 6B,D 9A,B, 10B,C, E, 11D,E ES Literacy Principles: 2.7, 2.3, 2.4, 8.1, 4.5	1 (50-minute) class periods

*We recommend that some labs in this module be assigned as homework.

	Content TEKS for Earth Systems Science											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS		D, E	B, D			A, B	B, C, E	D, E				
Envir. Sys					A, B							

Aq. Sci.												
IPC	F, G	C, G, I										
8TH Grade					A							

	Literacy Principles Addressed by Earth, the Habitable Planet								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science	1.4, 1.6	2.2, 2.3, 2.4, 2.5, 2.7	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7	4.5				8.1	

TXESS Revolution Chapter 2: Earth System Science. Earth is a comprehensive system of dynamic, interacting components. Understanding how the Earth system works is essential for preparing students to make informed decisions about how to manage, protect, and sustain our planet and its natural resources. Coral reefs, often compared to rainforests for the vast biodiversity they support, are under threat from human activities and global warming. Studying them provides a deeper understanding of how one of Earth's sub-systems is responding to environmental change.

Time: **15** 50-minute class period (about 3 weeks)

Learning Objectives

Students will know

- How we describe Earth as a system
- How energy and matter are exchanged among the four main components of the Earth system (atmosphere, biosphere, hydrosphere, pedosphere)
- How Earth system changes over time
- How life is affected by changes in the Earth system
- The factors that influence coral reef health
- How coral reefs respond to environmental change such as warming ocean temperatures

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
***EarthLabs: Earth System Science** **http://serc.carleton.edu/earthlabs/climate/index.html** Set of seven online learning activities designed to help students explore the connectedness of the earth system. Developed by TERC for EarthLabs	Online learning modules that utilize several instructional strategies, including guided inquiry using real data and visualizations, model building, and video-enhanced instruction.	ESS: 11A, C; 13D; 14C; 15A. ES Literacy Principles:3.1,3.2, 3.3,3.4,3.5,3.6,3.7	9 (50-minute) class periods
***EarthLabs: Corals** **http://serc.carleton.edu/earthlabs/corals/activities.html** Set of six lab activities designed for students to explore corals as environmental indicators. Specifically, students are introduced to coral reef ecosystems and the importance of corals to humans, the factors that impact coral health, and coral bleaching. Developed by TERC for EarthLabs	Online learning modules that utilize several instructional strategies, including guided inquiry using real data and visualizations, model building, and video-enhanced instruction.	ESS: 11D, 15E ES Literacy Principles: 3.1, 3.2, 3.5, 3.6, 3.7, 3.8.	6 (50-min) class periods.

*We recommend that teachers assign selected EarthLabs activities as homework.

	Content TEKS for Earth System Science											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS								A, C, D, E		D	C	A, E
Envir. Sys					A, B							
Aq. Sci.												
IPC	F, G	C, G, I										
8TH Grade					A							

	Literacy Principles Addressed by Earth System Science								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science			3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7						

TXESS Revolution Chapter 3: Earth Outside In. Features observed at surface of our planet are in part manifestations of Earth's internal processes. This module introduces learners to plate tectonics as the framework for understanding how the Earth works. Students will discover plate tectonics as scientists originally did, by mapping the locations of earthquakes and volcanoes and examining real data collected by the Deep Sea Drilling Project in 1968. They will learn about plate boundaries, and how the processes that drive plate movements shape the earth. They will examine real data collected by UNAVCO for the EarthScope program to track plate motions, use Google Earth to explore active rifting, and analyze geochemical data to investigate the rates of tectonic processes in the southwest Pacific. Students will know: (1) how plate tectonic theory was developed; (2) how plates move and interact; (3) how scientists measure recent plate motion; (4) how plate reconstructions are created and their limitations.

Time: **15** 50-minute class period (about 3 weeks)

Learning Objectives
Students will know
- How plate tectonic theory was developed
- How plates move and interact
- The rates of plate motion
- How scientists measure recent plate motion

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
Discovering Plate Boundaries http://terra.rice.edu/plateboundary/index.html helps students appreciate the fundamentals of the theory of plate tectonics and its relevance to our modern understanding of earth science.	Direct teaching using lecture. Guided inquiry using maps, hands on activities and web-based visualizations.	ESS: 9A, 10A,B,C,E, 11C,D ES Literacy Principles: 2.4, 3.6, 4.3, 4.5	3 (50-minute) class periods
In the **Plate Tectonics Simulation Board Game** student consider processes and features along plate boundaries and develop a basic understanding of plate reconstruction models, such as **Texas Through Time** http://www.ig.utexas.edu/research/projects/plates/recons.htm#movies	Experiential learning using a board game to develop an understanding of web-based tools and visualizations that show plate reconstructions through time.	ESS: 9A, 10C, D 11B, C ES Literacy Principles 1.6, 2.1, 2.4, 3.6, 4.3, 4.5	2 (50-minute) class periods
Plate Tectonics and Contributions from Scientific Ocean Drilling http://www.oceanleadership.org/education/deep-earth-academy/	Direct teaching with lecture/ video to introduce students to scientific ocean drilling. Guided inquiry using real	ESS: 7A,C, 9C, 10A,C, D, E, 11D ES Literacy Principles: 1.4,	2 (50-minute) class periods

Students use data from the Deep Sea Drilling Project (DSDP) to test the hypothesis of seafloor-spreading.	data; may involve application of Google Earth. Students practice graphing skills.	1.5, 1.7, 2.1, 2.4, 3.4, 3.6, 4.3, 4.5	
Visualizing Relationships between Earthquakes, Volcanoes, and Plate Boundaries in the Western U.S. Using the EarthScope Jr. Data Tool http://cws.unavco.org:8080/cws/modules/regionalplatemotion_voyagerjr **Exploring Plate Motion and Deformation in California Using GPS Time Series Plots** http://cws.unavco.org:8080/cws/modules/GPSlessonplanCA/ (3)	Guided inquiry using real GPS data, and computer-based visualizations and tools (e.g., EarthScope Voyager, Jr.). Integrates concepts in mathematics (e.g., vectors)	10D, E, 11 B, C, D ES Literacy Principles: 1.4, 1.7, 3.4, 3.6	5 (50-minute) class periods

	Content TEKS for Earth Outside In											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS				A,B,C		A,C	A,B,C,D,E	C,D				
Envir. Sys			C		A,B							
Aq. Sci.												
IPC		G										
8TH Grade			C			A,B		C				

	Literacy Principles Addressed by Earth Outside In								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science	1.4, 1.5,1.7	2.2, 2.4	3.4, 3.6	4.3,4.5					

TXESS Revolution Chapter 4: Earth Inside Out. – still in development Time: 10 50-minute class period (about 2 weeks)			
Learning Objectives Students will know •			
Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment

	Content TEKS for Inside Out											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS												
IPC												
8TH Grade												

	Literacy Principles Addressed by Earth Outside In								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science									

TXESS Revolution Chapter 5: Geologic Time. Geologic time is a cross-cutting theme covered in all chapters in this blueprint. Geologic time is vast, and students sometimes have a hard time grasping this. Therefore, this chapter builds on the basic understanding that students have developed previous chapters to delve more deeply into geologic time, emphasizing the key understandings associated with stratigraphic layering and relative time. The most basic laws of stratigraphy are remarkably easy to understand, and profoundly important. The chapter also introduces absolute time, its measurement and geologic time scales.

Time: **4**-50-minute class period (about 1 week)

Learning Objectives
Students will know
- How geologic time is measured
- The process of radioactive decay
- How to apply the laws of stratigraphy and the Principle of Faunal Succession

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
A Brief Introduction to Geologic Time: Siccar Point	Direct teaching using lecture in combination with guided inquiry using hands on activities and web-based visualizations.	ESS: 7A,B,C, 8A, 9C ES Literacy Principles: 2.1, 2.7	1 (50-minute) class period
Stratigraphy and Evolution, Using Fossils to Tell Deep Time http://txessrevolution.org/FaunalSuccession	Direct teaching using lecture in combination with guided inquiry using hands on activities.	ESS: 7A,B,C, 8A, 9C ES Literacy Principles: 2.1, 2.6, 2.7	1 (50-minute) class period
Rocks of Cayuga Basin http://www.txessrevolution.org/drupal/?q=node/1642 Created by Nancy Spaulding and adapted by Larry Wood and Steve Kluge.	Guided inquiry activity in which students apply stratigraphic principles and faunal succession to interpret fossil data and use this data to put different rock layers in chronological order.	ESS: 7A,B,C, 8A, 9C ES Literacy Principles: 2.1, 2.6, 2.7	1 (50-minute) class period

	Content TEKS for Geologic Time											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS				A,B,C	A	C						

	Literacy Principles Addressed by Geologic Time								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science		2.1, 2.6, 2.7							

TXESS Revolution Chapter 6: Poking Holes into the Planet. Rocks we can see on the surface of the Earth are only a small part of the story of Earth history. This chapter begins with a review of the different rock types, and then digs below the surface with some large scale drilling operations. Students explore some big science in some distant places. They also learn about the technology used and the collaborative nature of science.

Time: **8**-50-minute class periods (about 1.5 weeks)

Learning Objectives

Students will know

- Igneous, metamorphic, and sedimentary rock types
- How and why coring and geophysical logging is done
- How to interpret geologic history from a core sample
- How to access and use real data
- How to relate sediment and rock type to physical, radioactive, and chemical properties in geophysical logs
- That science is a social, cooperative endeavor

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
Rock Identification Review http://txessrevolution.org/RockID_Intro This activity explores and identifies the different rock types: igneous, sedimentary and metamorphic (Use of Wards Rock Kits). Developed by Hilary Olson	Hands-on activity combined with direct teaching. Organized according to 5E model.	ESS: Not Applicable (covered in Middle School) ES Literacy Principles: 4.6	2 (50-minute) class periods
Build a Model Drillsite (Activity3A-BuildADrillsite.pdf) involves students in assembling a model of an ANDRILL drillsite. The ANDRILL project—ANtarctic geology DRILLing—recovers sedimentary rock cores from beneath Antarctica's ice to learn that continent's climate history. Developed by LuAnn Dahlman for ANDRILL's Antarctica's Climate Secrets collection.	Hands-on model building.	ESS: 7A, C; 11C; 13E	1 (50-minute class period)
Describing Cores http://txessrevolution.org/DescribingIntro Students use knowledge of sediment types to describe model cores and apply stratigraphic principles and faunal succession to carry out core-to-core correlation. Developed by Danielle Bailey, Marilyn Petkovsek, Gail Tynes, Katherine Ellins and Hilary Olson.	Hands-on, guided inquiry; students examine physical models.	ESS: 7A,C; 12A, E, 13E ES Literacy Principles: 4.8, 4.9, 6.1, 6.2	3 (50-minute) class periods
The Lost Continent (link) asks students to analyze geophysical log data from scientific ocean drilling, ODP Leg 183, to determine the boundary between seafloor sediments and underlying igneous rocks. Developed by Katherine Ellins and Tip Meckel.	Guided inquiry requiring analysis using graphing software (EXCEL) and web-based research.	ESS: 7A; 9A, C; 9C; 10A; 10C; 11A, 13E ES Literacy Principles: 2.4, 4.3, 4.4, 4.5, 4.6	2 (50-minute) class periods

	Content TEKS for Poking Holes Into the Planet											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS				A, C	A	A, C	A, C	A, C	A,E	E		

	Literacy Principles Addressed by Poking Holes Into the Planet								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science		2.4		4.3, 4.4, 4.5, 4.6, 4.8, 4.9		6.1, 6.2			

TXESS Revolution Chapter 7: The Water Planet

Water is arguably the most critical natural resource on the planet. This chapter explores water; on the surface, underground, and its absence. Students will learn about the relationship between surface and ground water. They will examine past evidence of evidence of drought.

Time: **9**-50-minute class periods (about 2 weeks)

Learning Objectives
Students will know
- How water moves through Earth's systems
- How groundwater is stored and retrieved
- The importance of ice
- What causes drought

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
EarthLabs Drought Module. The first two activities in this module set the stage for understanding the distribution of water and introduce learners to the concept of a watershed. **Where's the Water** http://serc.carleton.edu/earthlabs/drought/1.html **Watershed** http://serc.carleton.edu/earthlabs/drought/2.html Developed by TERC for EarthLabs	Online learning activities that utilize several instructional strategies, including guided inquiry using real data and visualizations, model building, and video-enhanced instruction.	ESS: 15A, C ES Literacy Principles: 5.5, 5.6	3 (50-minute) class periods
Understanding Surface Water and Groundwater Interactions http://txessrevolution.org/BartonSpringsIntro Students examine the relationship between surface water and groundwater using precipitation and groundwater discharge data collected at Barton Springs in Austin, Texas. Developed by Joel Stevens, Murry Fly, Katherine Ellins and Mark England.	Guided inquiry using real data and computer-facilitated graphing software for analysis; involves self-directed web-based research and use of visualizations; and direct teaching.	ESS: 13A, 15C ES Literacy Principles: 5.1, 5.5, 5.8	3 (50-minute) class periods
Climate and Civilization: The Maya Example http://txessrevolution.org/MayaExample This activity uses geophysical and geochemical data to determine climate in Central America during the recent past and to explore the link between climate change and population growth/demise among the Maya. Developed by Katherine Ellins, Jeri Rodgers, and James Cano	Guided inquiry using real data and computer-facilitated graphing software for analysis; direct teaching using video enhanced instruction.	ESS: 7A,B, 11E, 13A, B, C, D, E, F, 15B ES Literacy Principles: 3.4, 3.6, 3.7, 5.2, 7.5, 8.1, 8.5.	3 (50-minute) class periods

	Content TEKS for Earth the Water Planet											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS				A,B				E		A,B,C,D,E,F		A, B, C
Envir.Sys	A	B,E	A		A							
Aq.Sci.	A,C	A		A,B,C								

	Literacy Principles Addressed by Earth the Water Planet								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science			3.4, 3.6. 3.7		5.1, 5.2, 5.5, 5.6, 5.8		7.5	8.1, 8.3, 8.5, 8.7. 8.8	

TXESS Revolution Chapter 8: Earth's Cryosphere (http://serc.carleton.edu/earthlabs/cryosphere/index.html).
Students explore Earth's second largest reservoir of fresh water – the cryosphere. Over 100,000 glaciers cover 10 percent of the world's land and store 75 percent of the world's fresh water. Because much of the cryosphere is close to melting temperatures, it is one of the most powerful indicators of climate change. The cryosphere changes on a variety of timescales ranging from days to hundreds of thousands of years.

Eight online activities teach about the importance of the cryosphere, how scientists study the cryosphere to learn about past, present, and future changes in climate, and how those changes will impact life on Earth.

Developed by TERC for EarthLabs. Field-tested by Texas teachers.

Time: **12**-50-minute class periods (about 2.5 weeks)

Learning Objectives
Students will know
- What the cryosphere is
- Why the cryosphere is important?
- How and why the cryosphere changes over time and space
- The timescales associated with changes in the cryosphere
- The impacts and implications of changes in the cryosphere

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
Frozen in Time http://serc.carleton.edu/earthlabs/cryosphere/1.html Students explore the components of the cryosphere, annual changes in land and sea ice coverage, and ways that changes in the cryosphere are impacting human life	Online learning activities that use visualizations and video-enhanced instruction.	ESS: 11D; 13A ES Literacy Principles: 3.1, 5.1, 5.3, 5.5, 5.6, 5.7, 5.8, 8.3, 8.7. 8.8	1 (50-minute) class periods
Sea Ice Thermodynamics http://serc.carleton.edu/earthlabs/cryosphere/2.html Students explore properties of liquid and frozen salt water and how sea ice formation influences ocean currents.	Online learning activities involving learners in hands-on experimentation.	ESS: 11D; 13A, B ES Literacy Principles:3.2, 5.3	2 (50-minute) class periods
Sea Ice Dynamics http://serc.carleton.edu/earthlabs/cryosphere/3.html Students explore forces that influence sea ice dynamics, as well as changes in the distribution and composition of sea ice change over time. Developed by TERC for EarthLabs.	Online learning activities that utilize several instructional strategies, including guided inquiry using real data and interactive visualizations, model building, and video-enhanced instruction.	ESS: 11D; 13A, 15A ES Literacy Principles: 3.2, 3.3, 3.4, 5.3	1 (50-minute) class periods

Land Ice Thermodynamics http://serc.carleton.edu/earthlabs/cryosphere/4.html Students learn about land ice and the processes and timescales involved in glaciation. In Part B, they use an online interactive to explore how glaciers provide scientists with evidence for climate change.	Online learning activities that utilize several instructional strategies, including guided inquiry using real data and visualizations, model building, and video-enhanced instruction.	ESS: 11A, D; 13A ES Literacy Principles: 3.3, 3.4	2 (50-minute) class periods
Glacier Dynamics http://serc.carleton.edu/earthlabs/cryosphere/5.html Students learn about how and why glaciers move and make a model of a glacier.	Online learning activities that utilize guided inquiry using real data and visualizations, model building, and video-enhanced instruction.	ESS: 11A, D; 13 A ES Literacy Principles: 3.2, 3.3, 3.6, 5.6, 5.7	2 (50-minute) class periods
Interactions and Feedback http://serc.carleton.edu/earthlabs/cryosphere/6.html Students explore the ice-albedo feedback effect and learn how the reflectivity of ice helps regulate the planet's temperature.	Online learning activities that utilize guided inquiry using interactive visualizations, model building, video-enhanced instruction and hands-on experimentation.	ESS: 11D; 13D ; 14 A, B, C. ES Literacy Principles: 3.2, 3.3, 3.6. 3.7. 3.8	1 (50-minute) class period
Climate History and the Cryosphere http://serc.carleton.edu/earthlabs/cryosphere/7.html Students learn how scientists use ice cores from all over the world to glean information about past climate.	Online learning activities that utilize guided inquiry using interactive visualizations, analysis of real data, and vide0-enhanced instruction.	ESS: 13A, C; 15B ES Literacy Principles:3.4, 3.8	1 (50-minute) class period
Future of the Cryosphere http://serc.carleton.edu/earthlabs/cryosphere/8.html Students contemplate what the future might hold for climate and the cryosphere.	Online learning activities that utilize guided inquiry using interactive visualizations, analysis of real data, and hands-on experimentation.	ESS: 11D; 13A, C, D; 15B ES Literacy Principles: 1.5, 1.6, 9.1, 9.3, 9.9	2 (50-minute) class periods

	Content TEKS for Earth's Cryosphere											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS								A,D		A,C,D	A,B,C	B
Envir. Sys.			A,C, D,E		B	D, E, H, L						

	Literacy Principles Addressed by Earth's Cryosphere								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science	1.5, 1.6		3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.7, 3.8		5.1, 5.3, 5.5, 5.6, 5.7. 5.8				9.1, 9.2, 9.3, 9.9

TXESS Revolution Chapter 9: Earth's Climate System

Life on Earth depends on, is shaped by, and affects climate. Climate varies over space and time through both natural and man-made processes. Our understanding of the climate system is improved through observations, theoretical studies and modeling. Climate change will have consequences for the earth system and human lives.

Time: **15**-50-minute class periods (about 3 weeks)

Learning Objectives

Students will know

- How the elements of the climate system interact
- That there are natural, cyclical changes in climate
- That there are natural, non-cyclical changes in climate
- That there are human-caused changes in climate
- How to use geologic data to interpret past climates
- How climate change may affect extreme weather conditions

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
EarthLabs: Weather and Climate (IN DEVELOPMENT) Developed by TERC. Field-tested by Texas teachers.	Online learning modules that utilize several instructional strategies, including guided inquiry using real data and visualizations, model building, and video-enhanced instruction.		4 (50-minute) class periods
***EarthLabs: Normal Climate Patterns** http://serc.carleton.edu/earthlabs/drought/3.html Students generate and explore a variety of graphs, charts and map images in order to better understand the concept of normal climate. Developed by TERC	Online guided inquiry learning activity that uses real data, visualizations, and video-enhanced instruction.	ESS: 14 A, 14B	2 (50-minute) class periods
***EarthLabs: Hurricanes** http://serc.carleton.edu/earthlabs/hurricanes/index.html Labs 1, 2, 4 and 8. Hurricanes are complex natural phenomena that involve multiple interacting processes of the air, water, land, and life. Texas is affected by hurricanes. Developed by TERC	Online learning modules that utilize several instructional strategies, including guided inquiry using real data and visualizations, model building, and video-enhanced instruction.	ESS: 14C	4(50-minute) class periods
Using Microfossils to Understand Paleo-Climate http://txessrevolution.org/Microfossil_Intro This activity utilizes fossil data, specifically foraminifera, to explore climate. Developed by Hilary Olson	Hands-on, guided inquiry activity that uses real data; 5E model	ESS: 8A, 15B	2(50-minute) class periods
Paleoclimates and Pollen http://www.windows2universe.org/teacher_resources/teach_pollen.html Students study climate change by analyzing a model of pollen grains in soil samples to determine the type and amount of "pollen" in the samples, the type of vegetation and age of their samples. Developed by S. Henderson, S. Holman, and L. Mortensen (Eds.). EPA Report No. EPA/600/R--93/126	Hands-on, guided inquiry activity; model building.	ESS: 15B	3 (50-minute) class periods

- We recommend that teachers assign selected labs as homework.

	Content TEKS for Earth's Climate System											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS					A							B

	Literacy Principles Addressed by Climate System								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science		2.7	3.1, 3.3, 3.4, 3.7, 3.7, 3.8		5.1, 5.3, 5.5, 5.6, 5.7. 5.8				9.1, 9.2, 9.3, 9.9

TXESS Revolution Chapter 10: Energy, Resources and Energy and Climate –still in development

Time: **10**-50-minute class periods (about 2 weeks)

Learning Objectives
Students will know

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment

	Content TEKS for Energy, Resources and Energy and Climate											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS												
Envir. Sys.												

	Literacy Principles Addressed by Energy, Resources and Energy and Climate								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science									

TXESS Revolution Chapter 11: Extreme Events/ Extreme Environments

We live on a planet that is constantly changing, and some of those changes are sudden and catastrophic. Students love learning about that. This chapter highlights two extreme events, the most extreme – the asteroid impact that caused mass extinction at the end of the Cretaceous period – and the second, the recent devastating March 2011 Japan tsunami. Life on Earth occupies a wide range of environments, including deep in the ocean at mid-ocean ridges where microbes and a variety of exotic organisms thrive in the toxic brew that spews from hydrothermal vents.

Time: **15**-50-minute class periods (about 3 weeks)

Learning Objectives
Students will know

- The difference between extinction and mass extinction
- How to interpret evidence of an asteroid impact
- The causes, characteristics (deep water wave) and consequences of tsunamis
- About deep sea the hydrothermal vent ecosystem
- How chemosynthesis is a process by which microbes convert inorganic carbon to organic carbon through the use of chemical energy
- That the extreme environments at mid-ocean ridges may be similar to the conditions under which life originated

Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
K/T Calamity (link). Students will use real data collected by the Ocean Drilling Program to examine the response of foraminifera, single-celled marine organisms, to the K/T impact event. Developed by Katherine Ellins, Hilary Olson, Donna Clarke, and Joel Stevens	Hands-on, guided inquiry based activity using real data.	ESS: 7A, C; 8A, B, C ES Literacy Principles: 2.7, 3, 4, 3.5, 3.6, 3.7. 3.8, 6.1, 6.2, 6.6, 8.1	1 (50-minute) class period
Asteroid Impacts (IN REVISION). Students examine gravity data and seismic data to infer the presence of the buried Chicxulub impact crater. Developed by Matt Morris, Katherine Ellins and Gail Christeson	Hands-on, guided inquiry activities using real data and computer-facilitated data analysis, using contouring software package.	ESS: 7A, B, 8A, B,C ES Literacy Principles: 2.7, 3.7, 8.1	4 (50-minute) class periods
K/T Debate http://txessrevolution.org/AsteroidIntro Students participate in an in-class debate with the scenario that they are a senate sub-committee holding a public hearing to decide whether or not to fund a $50 billion planetary defense system. Developed by Tim Fennell	Interactive Instruction: Role-playing and debate. Learners work cooperatively to conduct research, and practice communication and listening skills. Learners read scholarly articles and use computers for web-based research.	ESS: 10C, E; 11E ES Literacy Principles: 2.7, 3, 4, 3.5, 3.6, 3.7. 3.8, 6.1, 6.2, 6.6, 8.1, 8.7	6 (50-minute) class periods
Tsunamis—Walls of Water Students explore the characteristics of tsunamis using math to understand wave energy, velocity, and height; and create a hazard map for a Hilo Hawaii in association with the Japan 2011 earthquake and tsunamis. Developed by Elizabeth Polito, Katherine Ellins, Sean Gulick and Nedra Bonal	Hands-on, guided inquiry using computer-facilitated data retrieval and analysis.	ESS: 10C ES Literacy Principles: 8.1, 8.5, 8.6, 8.7, 8.8	2 (50-minute) class periods
The Great Tubeworm Mystery: How Tubeworms and Microbes Work Together http://www.flexe.psu.edu/main/ECOLOGY_UNIT.cfm Students are introduced to role of bacterial chemosynthesis in deep-sea hydrothermal vent and cold seep tubeworms and learn about the symbiotic relationship between microbes and their tubeworm host.	Problem-based learning.	ESS:13 F ES Literacy Principles: 3.1, 3.2, 3.5, 6.3, 6.5, 6.9	2 (50-minute) class periods

	Content TEKS for Extreme Events/ Extreme Environments											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS				A, B, C	A, B, C		C, E	E		F		

	Literacy Principles Addressed by Extreme Events/ Extreme Environments								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science		2.7	3.4, 3.5, 3.6, 3.7, 3.7, 3.8			6.1, 6.2, 6.3, 6.5. 6.9		8.1, 8.5, 8.6, 8.7, 8.8	9.1, 9.2, 9.3, 9.9

TXESS Revolution Chapter 12: Humans at the Helm

This chapter addresses the interaction of human beings with the planet Earth. We look at human population and carrying capacity. Students learn about the challenge of feeding a growing population. We return to the topic of water in the context of global fresh water supplies. Finally, we examine the challenge of providing energy for a growing world.

Time: **13**-50-minute class periods (about 2.5 weeks)

Learning Objectives

Students will know

- How the law of exponential growth applies to populations
- How population is changing around the world
- How to evaluate the challenges of feeding, providing water, and providing energy for a growing world.
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Activities	Instructional Strategies	ESS TEKS and Literacy Principles	Time Allotment
Island Paradise http://txessrevolution.org/IslandIntro The case study presents the story of Easter Island, and its ecological collapse. Written as a jigsaw, in which students receive part of the story, and make predictions about what will later happen. Developed by Eleanour Snow	Case study in form of a jigsaw.	ESS: 11E ES Literacy Principles: 3.5,3.7, 9.1, 9.5, 9.6, 9.7, 9.8, 9.9	3 (50-minute) class periods
EarthLabs Drought: When Precipitation Patterns Change http://serc.carleton.edu/earthlabs/drought/4.html Students develop an understanding of the causes and symptoms of drought. They read background articles and prepare a physical model to illustrate the role that soil moisture plays in preventing or promoting drought.	Self-directed research reading scholarly articles and Google Earth exploration; guided inquiry using real data, and model-building.	ESS:15A ES Literacy Principles: 8.3, 8.7. 8.8	2 (50-minute) class periods
EarthLabs Drought: Is Your Region Ready for a Drought? http://serc.carleton.edu/earthlabs/drought/7.html In this lab, Students examine the economic, environmental, and social impacts of drought, prepare for, and stage, a mock community meeting to draw up plans to face drought. Developed by LuAnn Dahlman and Betsy Youngman for TERC.	Online learning activity that utilizes guided inquiry using real data, graphs and visualizations and interactive Instruction. Learners practice communication and listening skills.	ESS: 11E, 15A ES Literacy Principles: 8.3, 8.7. 8.8	3 (50-minute) class periods
EarthLabs Drought: Drought Mitigation Trade-offs http://serc.carleton.edu/earthlabs/drought/8.html Students explore how to reduce vulnerability to drought risk through mitigation strategies.	Online learning activity that involves students in web-based research and hands-on laboratory experiments.	ESS; 11E. 15C ES Literacy Principles: 8.3, 8.7. 8.8	4 (50-minute) class periods
The Great Energy Debate Game – http://www.need.org/needpdf/Great%20Energy%20Debate%20Game.pdf This activity allows students to debate the merits of various energy sources. Developed by NEED (National Energy Education Development Project)	Interactive instruction, debate. Learners practice communication and listening skills.	ESS: 12A, C, D S ES Literacy Principles: 8.3, 8.7. 8.8	1 (50 minute) class period

	Content TEKS for Extreme Events/ Extreme Environments											
TEKS	4	5	6	7	8	9	10	11	12	13	14	15
ESS								E	A,C,D			A, C

	Literacy Principles Addressed by Humans at the Helm								
Big Ideas	1	2	3	4	5	6	7	8	9
Earth Science			3.5, 3.7					8.1, 8.7, 8.8	9.1, 9.5, 9.6. 9.7. 9.8. 9.9