

Tennessee Science Curriculum Framework

Environmental Science

Course Description

Environmental Science is a laboratory course that enables students to develop an understanding of the natural and human-made environment and the environmental problems that the world faces. Students explore environmental science concepts through an inquiry approach.

Environmental Science students investigate:

- Inquiry
- Technology and Engineering
- Earth Systems
- The Living World
- Human Population
- Water and Land Resources
- Energy Resources and Consumption
- Pollution and Waste Production
- Global Change and Civic Responsibility

Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Course Level Expectations

CLE 3260.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.

CLE 3260.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.

CLE 3260.Inq.3 Use appropriate tools and technology to collect precise and accurate data.

CLE 3260.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.

CLE 3260.Inq.5 Compare experimental evidence and conclusions with those drawn by others about the same testable question.

CLE 3260.Inq.6 Communicate and defend scientific findings.

Checks for Understanding (Formative/Summative Assessment)

✓**3260.Inq.1** Develop a testable question for a scientific investigation.

✓**3260.Inq.2** Develop an experimental design for testing a hypothesis.

- ✓**3260.Inq.3** Select appropriate independent, dependent, or controlled variables for an experiment.
- ✓**3260.Inq.4** Perform an experiment to test a prediction.
- ✓**3260.Inq.5** Gather, organize, and transform data from an experiment.
- ✓**3260.Inq.6** Analyze and interpret the results of an experiment.
- ✓**3260.Inq.7** Use knowledge and data-interpretation skills to support a conclusion.
- ✓**3260.Inq.8** State a conclusion in terms of the relationship between two or more variables.
- ✓**3260.Inq.9** Compare the results of an experiment with what is already known about the topic under investigation.
- ✓**3260.Inq.10** Suggest alternative explanations for the same observations.
- ✓**3260.Inq.11** Analyze experimental results and identify possible sources of bias or experimental error.
- ✓**3260.Inq.12** Formulate and revise scientific explanations and models using logic and evidence.
- ✓**3260.Inq.13** Develop a logical argument about cause-and-effect relationships in an experiment.

Embedded Technology and Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations

- CLE 3260.T/E.1** Explore the impact of technology on social, political, and economic systems.
- CLE 3260.T/E.2** Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.
- CLE 3260.T/E.3** Explain the relationship between the properties of a material and the use of the material in the application of a technology.
- CLE 3260.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3260. T/E.1** Select appropriate tools to conduct a scientific inquiry.
- ✓**3260. T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
- ✓**3260. T/E.3** Explore how the unintended consequences of new technologies can impact human and non-human communities.
- ✓**3260. T/E.4** Present research on current bioengineering technologies that advance health and contribute to improvements in our daily lives.
- ✓**3260. T/E.5** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.

Standard 1 – Earth Systems

Conceptual Strand 1

Abiotic factors exert a profound influence on the global ecosystem.

Guiding Question 1

How do abiotic factors sustain life on earth?

Course Level Expectations

CLE 3260.1.1 Explain how earth's position in the solar system creates global climate patterns.

CLE 3260.1.2 Use the theory of plate tectonics to explain the occurrence of earthquakes, volcanoes, and tsunamis.

CLE 3260.1.3 Explain the rock cycle and its association with soil formation.

CLE 3260.1.4 Relate the atmosphere, hydrosphere and lithosphere to the biosphere.

Checks for Understanding (Formative/Summative Assessment)

✓**3260.1.1** Use a globe to explain the global circulation of the atmosphere integrating the uneven heating of Earth's surface and Earth's rotation.

✓**3260.1.2** Sketch and label a diagram of the layers of the atmosphere indicating distance above Earth's surface, temperature changes and other significant characteristics for each layer.

✓**3260.1.3** Use a one gallon container of water as a scale model to explain what percentage of water on Earth occurs as oceans, glaciers, freshwater and groundwater.

✓**3260.1.4** Compare heat transfer in the atmosphere and the oceans.

✓**3260.1.5** Describe how gases in the atmosphere affect climate.

✓**3260.1.6** Differentiate between divergent, convergent and transform plate boundaries.

✓**3260.1.7** Create a concept map depicting the rock cycle.

✓**3260.1.8** Relate erosion (weathering and transportation) to soil formation.

✓**3260.1.9** Differentiate between the hydrosphere, lithosphere and atmosphere.

Standard 2 – The Living World

Conceptual Strand 2

The global ecosystem involves interactions between biotic and abiotic factors.

Guiding Question 2

How do living things interact with each other and the abiotic components of the environment?

Course Level Expectations

CLE 3260.2.1 Employ the first and second laws of thermodynamics to explain energy flow within ecosystems.

CLE 3260.2.2 Discuss the roles of biodiversity and coevolution in ecosystems.

CLE 3260.2.3 Using temperature, latitude and altitude, infer the types of animal and plant life found in each of earth's major biomes.

CLE 3260.2.4 Distinguish between primary and secondary biological succession using common plants and animals.

CLE 3260.2.5 Explain biogeochemical cycling in ecosystems.

Checks for Understanding (Formative/Summative Assessment)

- ✓3260.2.1 Trace energy flow from the sun through living things.
- ✓3260.2.2 Diagram an energy/food pyramid that illustrates the 'Rule of 10'.
- ✓3260.2.3 Create a food web characteristic of a Tennessee ecoregion composed of at least four trophic levels. Extract two different, four trophic level food chains.
- ✓3260.2.4 Describe how species biodiversity relates to ecosystem stability.
- ✓3260.2.5 Describe plant and animal adaptations found in each of earth's major biomes.
- ✓3260.2.6 Identify the locations of earth's major biomes using a globe or map.
- ✓3260.2.7 Develop a visual display to compare and contrast primary and secondary biological succession in one of earth's major biomes or aquatic habitats.
- ✓3260.2.8 Explain how human activities such as lawn mowing, gardening, farming, logging, planting trees, mining, and urban development advance, halt, or slow succession.
- ✓3260.2.9 Draw and explain diagrams illustrating each of the following biogeochemical cycles: water, carbon, nitrogen and phosphorus.

Standard 3 – Human Population

Conceptual Strand 3

Worldwide, human population is growing exponentially.

Guiding Question 3

What factors affect human population growth?

Course Level Expectations

- CLE 3260.3.1** Demonstrate how human population growth over time has been affected by improved food production, healthcare, sanitation and industrial advances.
- CLE 3260.3.2** Research demographics and economic status of different countries to infer ecological and economic consequences of human population growth.
- CLE 3260.3.3** Explain how social and economic factors affect the fertility rate and life expectancy of the human population.

Checks for Understanding (Formative/Summative Assessment)

- ✓3260.3.1 Interpret and create graphs depicting human populations.
- ✓3260.3.2 Compare and contrast population growth rates and demographics for countries at various stages of economic development.
- ✓3260.3.3 Analyze age structure diagrams to predict population growth rates.
- ✓3260.3.4 Describe how the U.S. population experienced demographic transition.
- ✓3260.3.5 Use the concept of the ecological footprint to predict the ecological consequences of human population growth.
- ✓3260.3.6 Discuss pros and cons of methods used to manage a country's population growth.

Standard 4 – Water and Land Resources

Conceptual Strand 4

Humans use natural resources in a variety of ways.

Guiding Question 4

How can natural resources be sustainably managed for the benefit of all living things?

Course Level Expectations

CLE 3260.4.1 Examine common resource use practices in agriculture, forestry, urban/suburban development, mining, and fishing.

CLE 3260.4.2 Explore best management practices related to water and soil resources.

CLE 3260.4.3 Compare and contrast preservation and conservation.

CLE 3260.4.4 Evaluate the impact of human activities on natural resources.

Checks for Understanding (Formative/Summative Assessment)

✓**3260.4.1** Differentiate between renewable and nonrenewable resources.

✓**3260.4.2** Summarize how environmental problems (e.g., erosion, desertification, acid deposition, simplified ecosystems, and soil salinization) are associated with farming practices and soil conservation practices.

✓**3260.4.3** Investigate the impact of the green revolution on world food production and on the environment.

✓**3260.4.4** Investigate the pros and cons of producing crops through genetic engineering.

✓**3260.4.5** Summarize the ecological services and economic benefits provided by forests.

✓**3260.4.6** Summarize the environmental impact of extracting, processing, and using mineral resources.

✓**3260.4.7** Conduct a controlled experiment to determine effects of soil salinization on seed germination.

✓**3260.4.8** Use an environmentally significant case study (e.g., oil exploration in the Alaskan Wildlife Refuge) to explain the difference between preservation and conservation.

✓**3260.4.9** Summarize the roles of various public and private organizations (e.g., Nature Conservancy, Sierra Club, National Wildlife Federation, World Wildlife Fund, U.S. Forest Service, U.S. Fish and Wildlife, Bureau of Land Management, Department of Interior, Tennessee Wildlife Resource Agency, Tennessee Department of Environment and Conservation) involved in natural resource protection and use.

✓**3260.4.10** Research a Tennessee city, such as Chattanooga. Incorporate green design features into a plan for sustainable development in your community.

✓**3260.4.11** Research and summarize U.S. environmental laws related to natural resources (e.g., Resource Conservation and Recovery Act, Surface Mining Control and Reclamation Act, Food Quality Protection Act, Endangered Species Act, Soil Conservation Act, and National Park Service Act).

Standard 5 – Energy Resources and Consumption

Conceptual Strand 5

Humans use both renewable and nonrenewable sources of energy.

Guiding Question 5

What are the environmental consequences of energy use?

Course Level Expectations

CLE 3260.5.1 Compare and contrast various energy resources.

CLE 3260.5.2 Analyze the past and present use of energy resources.

CLE 3260.5.3 Predict future trends in energy resource use.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3260.5.1** Construct visual displays to illustrate the source, uses, advantages, disadvantages, availability, and cost of energy resources (i.e. coal, petroleum, nuclear, solar, hydro, wind, geothermal, biofuels, Hydrogen, tidal, “OTEC”).
- ✓**3260.5.2** Explain the concept of full cost pricing as it relates to electricity production.
- ✓**3260.5.3** Summarize renewable and nonrenewable energy use and consumption through time.
- ✓**3260.5.4** Compare the energy consumption of common appliances/electronic devices.
- ✓**3260.5.5** Describe energy saving alternatives to common appliances and electronic devices and explore energy saving alternatives.
- ✓**3260.5.6** Calculate personal carbon footprint and formulate plans for personal and commercial energy conservation.
- ✓**3260.5.7** Research technological advances in energy resources.
- ✓**3260.5.8** Research technological advances in energy conservation.

Standard 6 – Waste Production and Pollution

Conceptual Strand 6

Many human activities result in pollution.

Guiding Question 6

How can we mimic nature to provide goods and services for the growing human population in ways that do not pollute the environment?

Course Level Expectations

CLE 3260.6.1 Investigate the causes, environmental effects, and methods for controlling/preventing land, air and water pollution.

CLE 3260.6.2 Apply case studies to relate land, air, and water pollution to human health issues.

CLE 3260.6.3 Explore methods used for remediation of land, air and water pollution.

CLE 3260.6.4 Research local and national environmental legislation related to protecting land, air and water resources.

CLE 3260.6.5 Research local and state methods used for solid waste reduction, recycling and disposal; compare them to methods used in other developed countries.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3260.6.1** Differentiate between point and non-point sources of pollution as they apply to air and water.
- ✓ **3260.6.2** Conduct a watershed analysis of a local stream. Test for chemical and biological (infectious) pollutants include a survey of macro invertebrates.
- ✓ **3260.6.3** Investigate a state or local environmental issue involving pollution of land, air or water.
- ✓ **3260.6.4** Explore case studies of human health problems related to pollutants.
- ✓ **3260.6.5** Research major U.S. Environmental Legislation such as National Environmental Policy Act of 1969 (NEPA), The Clean Air Act, The Clean Water Act, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), The Oil Pollution Act of 1990 (OPA), The Pollution Prevention Act (PPA), The Resource Conservation and Recovery Act (RCRA), The Safe Drinking Water Act (SWDA), The Toxic Substances Control Act (TSCA).
- ✓ **3260.6.6** Compare and contrast industrial agricultural practices emphasizing use of petroleum based pesticides and fertilizers with organic methods of food production that utilize integrated pest management and organic composting.
- ✓ **3260.6.7** Conduct a survey about waste management/recycling habits and opportunities in your community. Report findings in an article written for a local newspaper, a pod-cast or on a local talk radio show.
- ✓ **3260.6.8** Investigate what watershed your school is located in and how wastewater, municipal solid and hazardous wastes are handled.

Standard 7 – Global Change and Civic Responsibility

Conceptual Strand 7

Human interaction with the local environment has global consequences.

Guiding Question 7

How do the decisions of one generation create opportunities and impose limitations for future generations?

Course Level Expectations

- CLE 3260.7.1** Explain how consumer choices in Tennessee impact jobs, resources, pollution and waste here and around the world.
- CLE 3260.7.2** Compare and contrast methods used by various governments to protect biodiversity.
- CLE 3260.7.3** Explain how human activity is related to ozone depletion and climate change.
- CLE 3260.7.4** Summarize the scientific explanation for average global temperature increase.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3260.7.1** Interview a senior citizen about past use and disposal of resources and compare with common practices today.
- ✓ **3260.7.2** Compare and contrast industrial agriculture and sustainable agriculture.
- ✓ **3260.7.3** Identify how environmental protection can be carried out on a local level and explain choices that can be made to lessen the impact on the environment.

- ✓**3260.7.4** Choose three endangered species and predict how their removal would affect the ecosystems in which they live.
- ✓**3260.7.5** Research the effectiveness of the U.S. Endangered Species Act.
- ✓**3260.7.6** Research major international environmental issues and how they are addressed by international agreements (Kyoto, Montreal, CITES, etc.).
- ✓**3260.7.7** Compare and contrast stratospheric and tropospheric ozone.
- ✓**3260.7.8** Define chlorofluorocarbons and explain how they break down ozone molecules.
- ✓**3260.7.9** Explain the trend in atmospheric CO₂ levels indicated by ice core data and CO₂ measurements recorded at Mauna Loa since 1958.
- ✓**3260.7.10** Predict the consequences of a warmer earth.