2018/2019

Environmental Science

Course Description and Curriculum Guide

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[redacted]

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Environmental Science

Course Description and Curriculum Guide

Course Description:

Environmental Science is one credit, year-long, laboratory-based science class that fulfils the graduation requirement for a laboratory science course at [redacted]. This course is designed to empower students with the necessary knowledge and skills that will enable them to apply scientific skills and processes to major environmental science concepts. Upon successful completion of this course, students should be able to use the scientific skills and processes and major environmental science concepts to understand interrelationships of the natural world and to analyze environmental issues and their solutions.

This course surveys key topic areas including the application of scientific process to environmental analysis; ecology; energy flow; ecological structures; earth systems; and atmospheric, land, and water science. Topics also include the management of natural resources and analysis of private and governmental decisions involving the environment. Students explore actual case studies and conduct five hands-on, unit-long research activities, learning that political and private decisions about the environment and the use of resources require accurate application of scientific processes, including proper data collection and responsible conclusions.

Primary Text: Withgott, J (2011). *Environmental Science.* Boston, Massachusetts: Pearson Education Inc.

Time Allotment: 50 minutes per day, 5 days per week

Pre-requisite: None

Grades: 10/11/12

Year at a Glance[1]

Month	Topics
August	Man and Nature
September	Man and Nature Ecology Part I
October	Ecology Part I Ecology Part II
November	Ecology Part II Human Environments
December	Human Environments
January	Natural Resources Part I
February	Natural Resources Part II
March	Climate Change Energy Resources
April	Energy Resources Waste Management
May	Public Policy and Environmental Activism

[1] The names of the units were given by Chris Tennant upon rewriting of the curriculum guide, and are NOT the same units as listed in the book.

Unit 1: Man and Nature[2]

Time frame: 3 weeks	**Text Section:** Chapters 1, 2, 3
Unit Content: • Why environmental science is important • How we interact without our environment, and what that means for both us and the planet • Ways we govern the environment • Ways we collect environmental data and how this data determines how we manage our environment • How to use the scientific method in environmental science • Analysing maps, data, graphs, and infographics • Using the metric system • Earth as a series of interconnected environmental systems • Ecological footprint **Standards:** 12ASI2.1 12ASI2.2 12ASI2.3	**Objectives:** Students will… • Consider the Christian stances on environmental issues from a variety of perspectives • Form a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. • Design a lab as a class to test a hypothesis of the class's choosing • Know good examples of what science is and is not • Identify questions and concepts that guide scientific investigations • Know why Easter Island collapsed, and how that relates to our interactions with the environment today • Understand how man's relationship to his environment is governed in public policy • Understand how market dynamics affect how we interact with/what we take from our environment • Be able to describe the ecological footprint of various activities
Biblical Integration: • Discussion of Dr. Lytton Musselman's lecture • Describe ways we can care for Creation • Teaching a biblical view on Christian environmental concern	**Hands-on Activities:** • Students design and execute their own lab testing a hypothesis of their choice followed by an abbreviated version of the IRP
TCK Standards:	**Assessment:** • Reflection paper on Christians in environmental science • Critique of a mock scientific report • Test 1: Man and Nature Unit
Technology Integration: •	**Additional Resources:** • Dr Lyton Musselman's lecture • The Secret Life of Plants movie as an example of what science is NOT • Case Study: Easter Island

[2] Skip the material under the heading "The Environmental Policy Process" on pages 53-55 as you will cover this at the end of the year

Unit 2: Ecology
Part I: Non-living Factors

Time frame: 3-4 weeks

Text Section: 3, 5.3, 6, 7.1

Unit Content:
- Earth as a series of interconnected systems
- Characteristics of the lithosphere, atmosphere, hydrosphere, and biosphere
- Biotic and abiotic factors
- Ecosystems and biomes
- Climates and climatographs
- Aquatic biomes
- Biogeochemical cycles and their importance for life
- The importance of wetlands
- Energy Flow in Ecosystems
- Food webs and energy pyramids
- The importance of biodiversity

Standards: 12FSPSP4.1
12FSPSP4.2
12FSPSP5.1
12FSPSP5.2
12FSPSP5.3

Objectives: Students will…
- Know the 4 main "spheres" of Earth's surface and what the differences between them are
- Know examples of these spheres interacting with each other and how changes in one sphere can affect operations in another
- Be able to give examples of biotic and abiotic factors, and describe how abiotic factors determine the biotic factors in an environment
- Know what a climatograph is and be able to use it to describe specific biomes
- Know the defining features of aquatic biomes
- Learn how energy enters and flows through an ecosystem and how this can affect various biogeochemical cycles
- Know how the removal of solid rock and fossil fuels by humans during the carbon and phosphorus cycles can affect the surface environment
- Know how food webs and energy pyramids work
- Understand the importance of wetlands
- Understand what biodiversity is, why it's important, and ways it is distributed throughout an ecosystem

Biblical Integration:

Hands-on Activities:
- Inquiry lab "How do Brine Shrimp Select a Habitat?" (Holt)
- Lab: Eutrophication: Too Much of a Good thing? (Holt)
- Lab: Population Growth (Holt)
- Have students teach one of the elementary school science classes about a land or aquatic biome

TCK Standards:

Assessment:
- Test 2: Ecology Part I

Technology Integration:
- Students use remote sensing sites to observe a natural environment to determine its health and potential threats to it

Additional Resources:
- Case Study: How Ecosystems Change
- Case Study: Hurricane
- Field Study: Ecosystems
- Aral Sea Depletion and Uzbekistan Cotton Production Case Study

Unit 2: Ecology
Part II: Living factors

Time frame: 3-4 weeks	**Text Section:** 4, 5.1, 5.2, 7.2, 7.3
Unit Content: • Individuals and populations • Principles of population growth • Population distribution • Survivorship curves and sex ratios • Niches, competition, and symbiosis • Natural selection and evolution • Speciation, extinction, habitat loss, and loss of biodiversity • Evolution and natural selection • Ways to protect biodiversity	**Objectives:** Students will… • Know characteristics that define organisms on both an individual and a population level • Know how populations grow, stabilize, and decline • Understand ways populations are distributed • Identify which type of survivorship curve various organisms belong to and why • Know how sex ratios affect a population • Understand how population dynamics help drive evolution • Understand the differences between natural and artificial selection • Know how natural selection, combined with the other 3 forces of evolution, leads a species to become adapted to its environment over many generations • Know and understand the conditions needed for natural selection to work • Understand the relationship between selection pressure and change in a population's genetics • Understand ways both habitats and biodiversity can be lost and know various ways to protect that biodiversity
Standards:	
Biblical Integration:	**Hands-on Activities:** • Field trip to Shomari Wildlife Preserve to study biodiversity
TCK Standards:	**Assessment:** • Test 3: Ecology Part II • Students write and publish an article about the efforts of Shomari Nature Reserve to restore species
Technology Integration:	**Additional Resources:** • Case Study: Population Growth • Case Study: Darwin's Finches (Holt) • Case Study: Biodiversity and Extinction • Population Dynamics of the 10 Plagues of Egypt Lab

Unit 3: Human Environments
Part I: The Human Population

<table>
<tr><td>Time frame: 2 weeks</td><td>Text Section: Chapter 8</td></tr>
<tr><td>Unit Content:
The industrial and agricultural revolutions
Defining trait of humankind and diversity of human cultures
Population dynamics of the human race
The developed and developing world
Development of technology
Standards:</td><td>Objectives: Students will…
Know what the agricultural and industrial revolutions are, and how these changed the way we interact with the environment
Understand what the human population was like both before and after the agricultural and industrial revolutions
Understand how population dynamics applies to the human race
Identify traits that make mankind unique, and understand the diversity of human culture on Earth
Know things that affect fertility rate and understand how sex ratios and age structure apply to human populations
Compare and contrast the ecological footprint of affluent and developing societies, and know the pros and cons of each
Understand how development of technology benefits mankind</td></tr>
<tr><td>Biblical Integration:</td><td>Hands-on Activities:
Have students research any 1-3 nations or human cultures on Earth and describe the differences in how people live there compared to other areas. This can also be done as an interactive presentation with food, traditional dress, and language</td></tr>
<tr><td>TCK Standards:</td><td>Assessment:</td></tr>
<tr><td>Technology Integration:</td><td>Additional Resources:</td></tr>
</table>

Unit 3: Human Environments **Part II: Cities**	
Time frame: 1 week	**Text Section:** Chapter 10
Unit Content: • Urbanization • Land use and land cover • Urban sprawl • Cities as heat islands • Zoning • Sustainable cities	**Objectives:** Students will… • Know what urbanization is and know its advantages and disadvantages • Know the difference between land use and land cover • Explain how and why urban sprawl occurs • Know the impact sprawl has on a city and its people • Look at the development of Amman over the decades and explain how sprawl and other urbanization principals apply to the development of the city • Know what a heat island is and why cities ae an especially good example of this • Explain examples of zoning in a city • Explain ways to keep urbanization sustainable
Standards:	
Biblical Integration:	**Hands-on Activities:** • Use Google Earth to look at the layout of Amman
TCK Standards:	**Assessment:**
Technology Integration: •	**Additional Resources:** •

Unit 3: Human Environments **Part III: Hazards and Industrial Practices**	
Time frame: 1 week	**Text Section:** Chapter 9
Unit Content: • Types of hazards • Emerging diseases • Indoor hazards • Carcinogens • Bioaccumulation and biomagnification	**Objectives:** Students will… • Know the 4 types of environmental hazards and be able to give examples of each • Know how emerging diseases develop and spread and know how to prevent this • Know examples of hazards that can occur inside a home, and know how to protect against them • Know what a carcinogen is and give examples • Know what bioaccumulations and biomagnification are, know how they happen, and know why they're dangerous
Standards:	
Biblical Integration:	**Hands-on Activities:** •
TCK Standards:	**Assessment:**
Technology Integration: •	**Additional Resources:** • Types of Emerging diseases research project

Unit 4: Natural Resources[3]

Part I: Geosphere and Biosphere

Time frame: 4-5 weeks	**Text Section:** Chapters 11, 12, 13
Unit Content: • Classification of natural resources • Resource management practices • Soils, and soil as a resource • Agriculture, and food as a resource • Pest control • Forestry, and forest resources • Mining, and effects of mining • Rocks and minerals • Weathering, erosion, and deposition • The Dust Bowl • Desertification and deforestation **Standards:** 12FSPSP6.4 12FSPSP6.5	**Objectives:** Students will… • Identify renewable, nonrenewable, and perennial resources • Know the 3 approaches to natural resource management • Know the layers of a forest canopy • Know ways pests can harm agriculture, and methods of how these pests are controlled • Give examples of sustainable vs. unsustainable agriculture • Understand how unsustainable agricultural practices lead to the Dust Bowl • Understand modern agricultural issues affecting Jordan • Understand the purpose of seed banks • Know how weathering, erosion, and deposition affect a landscape • Know the 6 soil horizons and what each layer contains • Know the 4 types of soil classification • Know examples of how minerals are used in everyday life • Know how desertification and deforestation affect Earth • Know how rocks and minerals are formed • Know the various ways minerals are mined • Give examples of the negative effects of mining
Biblical Integration:	**Hands-on Activities:** • Testing Water Quality in Jordanian streams • Lab: Extraction of Copper from Its Ore (Holt) • Case Study: Effects of Mining (Holt) • Mineral, soil, and agricultural maps/data from around Jordan and the world [4]
TCK Standards:	**Assessment:** • Interpretation of a case study • Test 5: Natural Resources Part I
Technology Integration:	**Additional Resources:** • Create a mock interview with a participant in the World Solar Challenge • Field trip to the Landmark Hotel greenhouse

[3] The Waste Management unit (unit 7) may also be moved to take place after the end of Human Environments but before Natural Resources I. This helps to transition the class from human-centered thinking back to thinking about nature.

[4] Forbes has these in his "Jordan Env" folder and Tennant has these in his "Handouts and Activities" folder. These can be very helpful for applying the natural resources lessons to student's lives and human activity

Unit 4: Natural Resources
Part II: Hydrosphere and Atmosphere

Time frame: 3-4 weeks

Text Section: Chapters 14, 15

Unit Content:
- Water as a critical resource
- Sources of freshwater
- Ways we use water resources
- Water pollution and water quality
- Wastewater treatment
- Ways we manage air and water pollution
- Effects of air and water pollution
- Characteristics of the atmosphere, including weather, clouds, and air masses/fronts
- The Coriolis effect
- Sources and forms of air pollution
- Photosynthesis and cellular respiration

Standards: 12FSPSP4.1
12FSPSP4.2
12FSPSP5.1
12FSPSP5.2
12FSPSP5.3
12FSPSP6.4
12FSPSP6.5

Objectives: Students will…
- Understand why water is the most important natural resource available
- Know where freshwater resources come from
- Identify and explain sources and health effects of indoor and outdoor air pollution, heavy-metal pollution, and water pollution
- Know ways we treat and recycle wastewater
- Measure water quality during a field study
- Identify forms and sources of water pollution and their effect on the environment and your body
- Know how clouds form, what causes wind, and how air masses interact to form fronts
- Know what causes weather, including severe weather, and how weather can impact human societies
- Understand how the Coriolis Effect determines global wind patterns
- Identify sources and forms of air pollution and their effect on the environment and your body
- Understand the relationship between photosynthesis and cellular respiration in terms of carbon dioxide and oxygen production

Biblical Integration:

Hands-on Activities:
- Lab: The Acid Test (Holt)
- Air quality study
- Water quality study
- Lab: Solid Wastes in Your Lunch (Holt)
- Field Study: Pollution
- Lab: Lead Poisoning and Mental Ability (Holt)

TCK Standards:

Assessment:
- Test 6: Natural Resources Part II

Technology Integration:
-

Additional Resources:
- "A World Without Water" movie (2006)
- Field trip to Azraq Wetlands
- Field trip to the water treatment plant in Salt
- Case Study: Air Pollution and Acid Rain
- Case Study: Water
- Antarctica Data Interpretation Worksheet

Unit 5: Climate Change

Time frame: 2-3 weeks	**Text Section:** Chapter 16
Unit Content: • Climate cycles vs. climate change • Greenhouse gasses • Examples of climate change • Solutions to modern climate change issues • Past climates • Impact of climate change on the biosphere and human civilization	**Objectives:** Students will… • Understand the correlation between greenhouse gas increase, human population increase, waste output from industrialized societies, and a changing global climate • Understand how greenhouse gasses affect the heat intake of the atmosphere, and how this affects the biosphere • Understand the difference between climate cycles and climate change • Be able to explain how past environments are good indicators of future change, and give examples of how past climates have changed the human population at different times • Understand methods we use to understand and interpret past climates • Examine several case studies of climate change around the globe and be able to explain how those changes can have rippling effects across the globe • Come up with their own solutions to modern climate change issues based on the information they are given about those issues
Standards:	
Biblical Integration:	**Hands-on Activities:** • 2049 Game
TCK Standards:	**Assessment:**
Technology Integration: •	**Additional Resources:** • Articles exploring what kinds of environmental factors contributed to the fall of Rome, Chaco Canyon, Khmer, and other major civilizations/empires and how this applies to our lives today

Unit 6: Energy Resources

Time frame: 2-3 weeks	**Text Section:** Chapters 17, 18
Unit Content: • Energy, and forms of energy • Energy transfer • Uses of energy • Renewable energy • Fossil fuels and natural gas • Consequences of fossil fuel use • Nuclear energy • The Chernobyl Disaster, its effects, and how it could have been prevented • Alternative energy • Energy conservation	**Objectives:** Students will… • Know what energy is, and give examples of different forms of energy • Understand ways energy can be transferred • Know how energy is used • Know how fossil fuels and natural gas form, and how they are used by people living in industrial societies • Know how fossil fuel use can negatively impact the environment • Understand how a nuclear reactor generates electricity, and know the benefits and costs of nuclear power • Be able to describe what happened at Chernobyl, why it happened, and the lessons the world learned from that • Learn about different methods of generating electricity, including alternative methods that use renewable energy sources • Understand how each of the method of renewable energy capture transfers energy from one form to another, and how that transfer generates electric power • Conduct an electrical or heat audit on a building and make proposals on the most efficient way to fix inefficiency issues • Compare and contrast different methods of electrical power generation • Be able to describe what happened at Chernobyl, why it happened, and how it could have been prevented • Know ways energy can be conserved
Standards:	
Biblical Integration:	**Hands-on Activities:** • Lab: Blowing in the Wind (Holt) • Making a Hotdog Cooker Lab
TCK Standards:	**Assessment:**
Technology Integration: •	**Additional Resources:** • Chernobyl Differentiated Learning Project

Unit 7: Waste Management[5]

Time frame: 2 weeks	**Text Section:** Chapter 19
Unit Content: • Examples of waste • Waste disposal • Composting and recycling • Waste management and public health • Environmental effects of improper waste management • Hazardous waste	**Objectives:** Students will… • Know the differences between municipal, industrial, and hazardous waste, and give examples of each • Know ways we dispose of and manage waste • Understand the relationship between waste management and public health and safety • Understand ways to compost or recycle various commonly wasted objects such as t-shits, jeans, food scraps, coffee grounds, plastic bottles, water, paper, aluminum cans, etc. • Understand the environmental effects of improper waste disposal • Come up with a waste management campaign for the school to encourage better waste management practices • Know different kinds and examples of hazardous waste and how it can be managed
Standards:	
Biblical Integration: • Why we should be good stewards of God's Creation through waste management	**Hands-on Activities:** • Solid Wastes in Your Lunch Lab (Holt) (this can also be applied to trash in student's homes over the course of a 24-hour period) • Come up with a waste management campaign to encourage elementary and middle school students to reduce/recycle • Students teach the elementary students about recycling using their own hands on-activities
TCK Standards:	**Assessment:** Quiz 9: Waste Management
Technology Integration: •	**Additional Resources:** • Research what kinds of waste comes out of hospitals and what happens to it after disposal

[5] The Waste Management unit may also be moved to take place after the end of Human Environments but before Natural Resources I. This helps to transition the class from human-centered thinking back to thinking about the environment.

Unit 8: Public Policy and Environmental Activism[6]

Time frame: 2-3 weeks	**Text Section:** "The Environmental Policy Process" on pages 53-55
Unit Content: • The politics of managing the environment • The relationship between science, politicians, and the public • The 6 steps to passing an environmental law • Differences in passing environmental laws in different countries • The importance of environmental activism • Public art as a medium to communicate awareness of environmental issues	**Objectives:** Students will… • Look at each unit of the class through the lens of a policymaker • Understand why scientists need politicians and the public in order to make changes to how we interact with our environment • Know the six steps to passing an environmental law and examine how this could be done for an issue of the student's choice. • Examine the difference in the process of passing laws (especially environmental laws) in Jordan and other countries around the world • Understand the importance of environmental activism in passing environmental laws • Learn ways to communicate the lessons of the class to the community using an art project • Execute an art project (such as a small mural, yarn bombing, or sidewalk chalk drawing) in a publicly available space to promote awareness of any environmental issue discussed during the school year
Standards: 12FSPSP6.1 12FSPSP6.2 12FSPSP6.4 12FSPSP6.3	
Biblical Integration:	**Hands-on Activities:** • Case Study: Passing an Environmental Law • Students do a "yarn bombing" or sidewalk chalk street art/graffiti campaign in front of the school to promote environmental awareness
TCK Standards:	**Assessment:**
Technology Integration: •	**Additional Resources:** • Visit to RSCN to learn about how environmental laws are passed in Jordan and what areas are of major concern at the reserve • Students write a proposal for an environmental law

[6] Since there is no supporting material in the book for most of this unit, the teacher should feel free to modify the material covered here on an as-needed basis. The complexity and length of the end-of-year environmental street art campaign in particular depends on how many days are left in the year and can be removed entirely in the event the teacher is already too far behind.

Appendices

[redacted] Science Standards for Environmental Science

Abilities necessary to do scientific inquiry

12ASI1.1 Identify questions and concepts that guide scientific investigations. Students should form a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and conceptual understanding of scientific investigations.

12ASI1.2 Design and conduct scientific investigations. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.

12ASI1.3 Use technology and mathematics to improve investigations and communications. A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this standard. Mathematics plays an essential role in all aspects of an inquiry. For example, measurement is used for posing questions, formulas are used for developing explanations, and charts and graphs are used for communicating results.

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation.

12ASI1.5 Recognize and analyze alternative explanations and models. This aspect of the standard emphasizes the critical abilities of analyzing an argument by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.

12ASI1.6 Communicate and defend a scientific argument. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language

appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.

Understandings about scientific inquiry

12ASI2.1 Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

12ASI2.2 Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.

12ASI2.3 Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.

12ASI2.4 Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results

12ASI2.5 Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge.

12ASI2.6 Results of scientific inquiry — new knowledge and methods — emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. In addition, the methods and procedures that scientists used to obtain evidence must be clearly reported to enhance opportunities for further investigation.

Science and Technology (12EST)

Abilities of technological design

12EST1.1 Identify a problem or design an opportunity. Students should be able to identify new problems or needs and to change and improve current technological designs.

12EST1.2 Propose designs and choose between alternative solutions. Students should demonstrate thoughtful planning for a piece of technology or technique. Students should be introduced to the roles of models and simulations in these processes.

12EST1.3 Implement a proposed solution. A variety of skills can be needed in proposing a solution depending on the type of technology that is involved. The construction of artifacts can require the skills of cutting, shaping, treating, and joining common materials - such as wood, metal, plastics, and textiles. Solutions can also be implemented using computer software.

12EST1.4 Evaluate the solution and its consequences. Students should test any solution against the needs and criteria it was designed to meet. At this stage, new criteria not originally considered may be reviewed.

12EST1.5 Communicate the problem, process, and solution. Students should present their results to students, teachers, and others in a variety of ways, such as orally, in writing, and in other forms - including models, diagrams, and demonstrations.

Understandings about science and technology

12EST2.1 Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry often emerge at the interface of two older disciplines.

12EST2.2 Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.

12EST2.3 Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

12EST2.4 Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans adapt, and fulfill human inspirations. Technological solutions may create new problems. Science, by its nature, answers questions that may or may not directly influence humans. Sometimes scientific advances challenge people’s beliefs and practical explanations concerning various aspects of the world.

12EST2.5 Technological knowledge is often not made public because of patents and the financial potential of the idea or invention. Scientific knowledge is made public through presentations at professional meetings and publications in scientific journals.

Science in Personal and Social Perspectives (12FSPSP)

Personal and community health

12FSPSP1.1 Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms — sensory, motor, emotional, social, and technological — that can reduce and modify hazards.

12FSPSP1.2 The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted.

Population growth

12FSPSP2.1 Populations grow or decline through the combined effects of births and deaths, and through emigration and immigration. Populations can increase through linear or exponential growth, with effects on resource use and environmental pollution.

12FSPSP2.2 Various factors influence birth rates and fertility rates, such as average levels of affluence and education, importance of children in the labor force, education and employment of women, infant mortality rates, costs of raising children, availability and reliability of birth control methods, and religious beliefs and cultural norms that influence personal decisions about family size.

12FSPSP2.3 Populations can reach limits to growth. Carrying capacity is the maximum number of individuals that can be supported in a given environment. The limitation is not the availability of space, but the number of people in relation to resources and the capacity of earth systems to support human beings. Changes in technology can cause significant changes, either positive or negative, in carrying capacity.

Natural resources

12FSPSP3.1 Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.

12FSPSP3.2 The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.

12FSPSP3.3 Humans use many natural systems as resources. Natural systems have the capacity to reuse waste, but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

Environmental quality

12FSPSP4.1 Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.

12FSPSP4.2 Materials from human societies affect both physical and chemical cycles of the earth.

12FSPSP4.3 Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways human s view the earth.

Natural and human-induced hazards

12FSPSP5.1 Normal adjustments of earth may be hazardous for humans. Humans live at the interface between the atmosphere driven by solar energy and the upper mantle where convection creates changes in the earth's solid crust. As societies have grown, become stable, and come to value aspects of the environment, vulnerability to natural processes of change has increased.

12FSPSP5.2 Human activities can enhance potential for hazards. Acquisition of resources, urban growth, and waste disposal can accelerate rates of natural change.

12FSPSP5.3 Some hazards, such as earthquakes, volcanic eruptions, and severe weather, are rapid and spectacular. But there are slow and progressive changes that also result in problems for individuals and societies. For example, change in stream channel position, erosion of bridge foundations, sedimentation in lakes and harbors, coastal erosion, and continuing erosion and wasting of soil and landscapes can all negatively affect society.

12FSPSP5.4 Natural and human induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and tradeoffs of various hazards — ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

Science and technology in local, national, and global challenges

12FSPSP6.1 Science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen. The latter involves human decisions about the use of knowledge.

12FSPSP6.2 Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science - and technology -

related challenges. However, understanding science alone will not resolve local, national or global challenges.

12FSPSP6.3 Progress in science and technology can be affected by social issues and challenges. Funding priorities for specific health problems serve as examples of ways that social issues influence science and technology.

12FSPSP6.4 Individuals and society must decide on proposals involving new research and the introduction of new technologies into society. Decisions involve assessment of alternatives, risks, costs, and benefits and consideration of who benefits and who suffers, who pays and gains, and what the risks are and who bears them. Students should understand the appropriateness and value of basic questions - "What can happen?" - "What are the odds?" - and "How do scientists and engineers know what will happen?"

12FSPSP6.5 Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use - which decreases space available to other species - and pollution - which changes the chemical composition of air, soil, and water.

Unit Template

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