PARSIPPANY-TROY HILLS TOWNSHIP PUBLIC SCHOOL DISTRICT

SCN334 AP ENVIRONMENTAL - HIGH SCHOOL

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I. OVERVIEW

The AP Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in Environmental Science. The goal of the AP Environmental Science course is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving or preventing them. Environmental Science is interdisciplinary; it embraces a wide variety of topics from different areas of study. Yet there are several major unifying constructs, or themes, that cut across the many topics included in the study of environmental science.

This course is aligned with the NEW JERSEY STUDENT LEARNING Standards for Science (NJSLS for Science), the NEW JERSEY STUDENT LEARNING Standards for Technology (NJSLS for Technology), 21st Century Standards and the Common Core State Standards for English Language Arts/Science and Technical Subjects Writing and Math. Separately we assess students to gauge progress and inform instruction. Benchmark assessments for students in grades 9 through 12 are administered in the form of a midterm and final exam for full year courses. *Special Note: Only final exams are administered at the end of quarter courses and semester courses.

II. RATIONALE

AP Environmental Science will be offered to students who excel in Biology and Chemistry. Students will have the opportunity to deepen their understanding of the natural phenomena that govern life on Earth and to develop a broader understanding of how human society and activities impact and are impacted by these phenomena. The course provides strong interdisciplinary connections between scientific principles, sociology, and government. Students will be consistently challenged to analyze real-world environmental issues and occurrences in order to assess cause and effect relationships, develop strategies for sustainable stewardship of the Earth, and innovate new ways to meet growing human demand for development and technology while maintaining balance in ecosystems.

III. STUDENT OUTCOMES (Link to New Jersey Student Learning Standards)

In accordance with district policy as mandated by the New Jersey Administrative Code and the New Student Learning Standards, the following are proficiencies required for the successful completion of the above named course.

The student will:

1. Understand the natural Earth systems including geosphere, hydrosphere, atmosphere, and biosphere and apply their understanding to the interconnected nature of these systems.

2. Understand the flow of energy and the cycling of matter within Earth's systems.

3. Understand population growth and limits to growth, and compare the human population to other populations on the planet and throughout the Earth's history.

4. Understand that human actions have a significant impact on the planet, specifically in relation to the use of land and water resources as well as how we meet our energy demands.

5. Understand how human activities often result in pollution of the air, water and soil; and how such pollution has significant impact on human health and the health of the planet.

6. Understand the need for regulation of human activities that impact the Earth and other species that share the planet.

7. Analyze environmental issues related to human activities and analyze the associated risks.

8. Understand what it means to be an environmental steward and to live sustainably.

9. Increase the students ability to apply scientific knowledge as a process to generate solutions to complex problems, to see the interrelatedness of all areas of study, and to make appropriate connections.

10. Enhance students ability to interpret various types of data summaries and utilize written and oral communication skills to share their findings.

Link to NEW JERSEY STUDENT LEARNING STANDARDS

- 3 - English Language Arts
- 4 - Mathematics
- 5 - Science
- 8 - Technology
- 9 - 21st Century Life and Careers

Modifications/Differentiation and Adaptations:
For guidelines on how to modify and adapt curricula to best meet the needs of all students, instructional staff should refer to the Curriculum Modifications and Adaptations included as an Appendix in this curriculum. Instructional staff of students with Individualized Education Plans (IEPs) must adhere to the recommended modifications outlined in each individual plan.

IV. ESSENTIAL QUESTIONS AND CONTENT

Overarching Essential Questions:

a) How do geological processes affect the environment?
b) How is the composition of the atmosphere related to its behavior?
c) How do aquatic systems interact with life on Earth?
d) What is the significant role of soil in relationship to life and how have humans impacted that role?
e) How is ecosystem stability related to energy flow and biodiversity?
f) How do demographic statistics help us understand population dynamics and the issues related to carrying capacity?
g) What are some rational ideas on how to meet the energy needs of the future?
h) What are the sources, effects and control measures of air, water and soil pollution?
i) What real impact do ordinances, laws and treaties have on past, present and future environmental issues?

Content:

Earth Systems and Resources

- How does the composition of the Earth impact geological activity?
- How is the atmosphere structured?
- How do atmospheric composition and oceanic patterns affect climate?
- How does human use of water resources impact ecological balance?
- What are the physical and chemical properties of soil and how do they impact land use?

The Living World

- How do organisms interact in ecosystems?
- How does energy flow in an ecosystem?
- How does ecosystem diversity impact stability and balance?
- How do nutrients cycle in ecosystems?

Population

- How are populations structured?
- What determines the carrying capacity for populations?
- How do human population dynamics vary globally?
- What are the implications of human population structures?

Land and Water Use

- How do we use agriculture to feed a growing population?
- What is the impact of various agricultural practices?
- How do we manage forests and rangelands?
- How do fishing practices impact ecosystems?
- How does mining impact ecosystems?
- How does urban land development impact ecosystems?
- How do global economics influence land and water use?
- What are sustainable land and water use alternatives?

Energy Resources and Consumption

- What forms of energy are currently used? in development?
- How does energy consumption influence energy source (i.e. fossil fuel, nuclear, hydroelectric, renewables) selection?
- How can conservation influence energy sustainability?
- How can renewable energy sources become more efficient?

Pollution

- What are the sources of air, noise, water, and waste pollution?
- What control measures are in place for air, noise, water, and waste pollution and how effective are they?
- What are the impacts of pollution on human health?
- What are the economic impacts of pollution reduction?

Global Change

- What is stratospheric ozone?
- What is the greenhouse effect and how do greenhouse gasses impact climate?
- What is the impact of loss of biodiversity on the planet?
- How do laws and treaties impact ozone depletion, climate change, and loss of biodiversity

V. STRATEGIES

- Student research based tasks
- Guided laboratory investigations
- Student designed laboratory investigations
- Student driven engineering tasks
- Group discussion
- Individual conferencing

VI. EVALUATION

Laboratory skills and communication: 30% - This grading component consists of skills, techniques, efficiency, and safety practices in the laboratory environment. It also includes: formal written lab reports, data analysis in a laboratory format, graphical analysis, experimental design, and conclusion statements.

Performance Based Assessments: - 30% - This category includes: research evaluations and projects, authentic assessment projects, performance based tasks, and analysis and synthesis of data.

Summative Assessments: - 30% - These assessments evaluate the student's ability to demonstrate in writing their knowledge and understanding of content. and the student's ability to utilize content to analyze and reason with data.

Class participation: 10% - This grading component assesses the student's ability to demonstrate verbally and in writing their knowledge and understanding of teacher-assigned reading and problem-solving challenges. This also includes the student's ability to actively engage in classroom activities that provide rational, logical, and comprehensive explanations to questions asked by the teacher and peers.

VII. REQUIRED RESOURCES

Books:

- Friedland, A. and Relyea, R. Environmental Science for AP Teacher Resource Binder. New York, NY. W.H. Freeman and Co., 2012.

Supplemental Resource

- Cunningham, W.P. and Cunningham, MA. Environmental Science: A Global Concern 14e, McGraw Hill, 2018.

Suggested Websites

http://bcs.whfreeman.com/friedlandapes/#t_668210

http://darwin.eeb.uconn.edu/eeb310/lecture-notes/diversity-stability.pdf

http://www.enviroliteracy.org/pdf/materials/1245.pdf

VIII. SCOPE AND SEQUENCE

1. **Earth Systems and Resources (20 days)**
   Apply understanding of: Earth Science concepts such as geological time scale, plate tectonics, and solar intensity and latitude; atmospheric concepts such as composition, structure, weather and climate, and atmosphere-ocean interactions; global water resources such as freshwater/saltwater supplies, ocean circulation, water use, and surface and groundwater issues; and soil dynamics concepts such as soil formation, physical and chemical properties of soil, soil problems, and conservation.

   Standards Covered:
   Science Standards: **HS-ESS1-5: HS-ESS2-1; HS-ESS2-2; HS-ESS2-3; HS-ESS2-4; HS-ESS3-5; HS-ESS3-6;**
   ELA Standards: **RST.9-10.8; RST.11-12.1; RST.11-12.2; SL.11-12.5; RST.11-12.8;**
   Math Standards: **HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.B.6;**
   Technology Standards: **8.1.12.A.4;**
   21st Century Standards: **CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.**
   Suggested Activities:
   a. Construct a scaled geological timeline - this can be done on a strip of paper roll or outside using sidewalk chalk.
   b. Using understanding of scaling cartography, label fault lines on a global map.
   c. Construct a working model of plate boundaries using various household materials.
   d. Research the geological, economical, historical and human impacts of a major event (hurricane, cyclone, earthquake, tsunami, etc) or geographic feature (mountain range, island chain, etc).
   e. Plot a hurricane or cyclone using current NOAA or NASA data.
   f. Model ocean currents using density, temperature, and air current.
   g. Access sea surface temperature and wind speed data from a NASA site, plot and compare data, draw conclusions about surface current and sea surface temperature, and link their gained understanding to concerns about global climate change.
   h. Use NOAA data for water elevation, moon phase, and tidal range data to correlate moon phase to tide.
   i. Complete a soil texture analysis and soil composition analysis using soil samples from various local (and non-local if available) microecosystems.
   j. Research and discuss various current events related to climate and soil.

   Teacher's Notes:
   This unit works nicely in the fall (during hurricane season and before the ground freezes). There is a lot of modeling and opportunity to introduce math and data skills as well.

2. **The Living World (15 days)**
   Apply understanding energy flow, biogeochemical cycles, and ecosystem diversity to

ecosystem structure. Discuss the dynamics of biological populations and communities and ecological niches and their influence on interactions among species and species diversity in major terrestrial and aquatic biomes.

Standards Covered:

Science Standards: HS-ESS2-6; HS-ESS2-7; HS-LS2-1; HS-LS2-2; HS-LS2-4; HS-LS2-5; HS-LS2-6; HS-LS2-7; HS-LS2-8;
ELA Standards: **RST.11-12.1; RST.11-12.2; SL.11-12.5;**
Technology Standards: **8.1.12.A.4;**
Math Standards: HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.B.6;
21st Century Standards: **CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.**

Suggested Activities:

a. HHMI Gorongosa food web modeling activity.
b. HHMI Gorongosa population data modeling activity.
c. Using a jigsaw technique, model biogeochemical cycles in a large format (on lab tables, or sidewalk using chalk). Have groups challenge one another by introducing an example of nutrient excess or a block to nutrient flow.
d. Albatross vs. owl pellet dissection and comparison
e. Keystone species case studies - for example wolves of Yellowstone or Effects of Coyote Removal in Texas (National Center for Case Study Teaching in Science).
f. Carolina primary productivity lab (or similar).

Teacher's Notes:

The topics in this unit should have all been covered in the students' biology class. The purpose of the activities cited is to review/reinforce and add detail as needed. The primary productivity lab is a longitudinal investigation and should be set up at the beginning of the unit for observation throughout.

3. Population (15 days)

Describe population sampling techniques and their benefits and limitations. Describe the structure and demographics of a population and how that impacts growth or decline. Analyze human population trends historically and globally. Predict population growth and impact on ecosystems.

Standards Covered:,

Science Standards: **HS-LS2-2; HS-LS2-6; HS-LS2-7; HS-LS2-8; HS-LS4-5;**
ELA ***Standards:*** **RST.11-12.1; RST.11-12.2;**
Math Standards: **SL.11-12.5, HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.A.1; HSS-IC.B.6;**
21st ***Century*** *Standards:* **CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.;**

Suggested Activities:

a. Jellybeans in a jar random sampling activity and math practice - assemble a jar of various jellybeans (similar to the "guess how many jellybeans" carnival activity and record proportions for each color. Mix the jar and have students randomly sample 10 beans from the jar at the beginning of class. Construct a class data table for frequency of each color in order to calculate the population structure.
b. Conduct a field study to estimate population of various grasses/weeds in the schoolyard.
c. HHMI Great Elephant Census activity.

d. Population growth lab with *Lemna minor* (duckweed).
e. Parking lot population diversity activity - conduct a study of population frequencies of various car types or manufacturers.
f. Raising Nemo Data Nugget on parental involvement and R/K selection.
g. Cemetery survivorship curve lab - can be done using online data or as a field trip to local cemetery to collect data.
h. Human population demographic tree construction and comparison activity.
i. Human population growth graphing activity (NOVA World in Balance)
j. Tragedy of the Commons activity

Teacher's Notes:
The population growth lab requires multiple weeks to acquire usable data. It may make sense to set both up in advance and use lab time for monitoring and other activities.

4. **Land and Water Use (20 days)**

Describe how human activity has reshaped land, soil, and water flow. Analyze impact of human activity on soil and water quality. Describe strategies for sustainable agriculture. Analyze mining practices for environmental and human safety and efficacy. Analyze and construct models for urban planning.
Standards Covered:
Science Standards: HS-ESS3-2; HS-LS2-2; HS-LS2-7; HS-LS2-8; **HS-ETS1-3;**
ELA Standards: **RST.11-12.1; RST.11-12.2; SL.11-12.5;**WHST.9-12.2; WHST.9-12.7;
Technology Standards: **8.2.12.C.6; 8.2.12.C.7;**
Math Standards: **HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.B.6;**
21st Century Standards: **CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.**

Suggested Activities:
a. Utilize a stream table to develop an understanding of how humans and nature can change the direction of water flow and what the consequences of that change will be.
b. Use the stream table to demonstrate the process of soil erosion and discuss the problems that it could cause.
c. Genetic engineering in crops research and debate.
d. Natural vs. Synthetic fertilizer lab.
e. Fertilizer and eutrophication lab.
f. Soil productivity lab (Carolina)
g. Eutrophication of the Chesapeake Bay case study (Museum of Natural History - Ecology Disrupted)
h. Bighorn Sheep case study (Museum of Natural History - Ecology Disrupted)
i. Sustainable agriculture research/interview project - students may research and/or interview local farms on agricultural practices and sustainability.
j. Urban planning project - students research various urban areas for relevant policies, strategies, and economic plans. Then, students use their analyses to design their own urban centers.
k. Cookie mining lab/economic simulation.
l. Copper extraction lab.

Teacher's Notes:
There are ample opportunities for guest speakers/field trips during this unit. Local farms may be able to host a short tour or send a speaker depending on time of year. Sandy Hook also has eco tours and educational programs that can align if time for a trip permits.

5. **Energy Resources (20 days)**
Describe various energy sources and how they produce power in terms of laws of conservation and thermodynamics. Describe the formation, extraction, and world reserves of fossil fuels. Describe the process, risks, and benefits to nuclear energy and hydroelectric power. Assess energy consumption pre and post industrial revolution and compare energy consumption across countries and cultures. Analyze renewable sources of energy for feasibility and environmental advantages/disadvantages.
Standards Covered:
Science Standards: **HS-ESS3-2; HS-ETS1-1; HS-ETS1-2; HS-ETS1-3;**
ELA Standards: **RST.11-12.1; RST.11-12.2; SL.11-12.5; RST.11-12.7; WHST.9-12.2;**
Technology Standards: **8.1.12.A.1; 8.2.12.A.1; 8.2.12.A.2; 8.2.12.B.2; 8.2.12.C.3; 8.2.12.C.4; 8.2.12.C.5; 8.2.12.C.6; 8.2.12.C.7;** *Math Standards:* **HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.B.6;** *21st Century Standards:* CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.

Suggested Activities:
a. Evaluate current sources of energy for extraction protocol, emissions, and efficiency using Switch Energy Lab video stations/rotation.
b. "How clean are electric cars?" research and position paper/presentation.
c. Engineering a windmill lab - students will test various blade numbers, shapes, orientation, etc. to determine the most efficient design for torque and power.
d. Collaborative learning jigsaw: Planet Money Buys Oil (NPR) - follow 100 barrels of oil from the ground, through a refinery and into someone's gas tank - why is oil everywhere, how did it get there, and what are the environmental and human costs?
e. Video discussion: Fracking explained: opportunity or danger (5 minutes) - are the benefits worth the risks?
f. Engineering Design: Hydrogen Fuel Cell Model Car Challenge - 4 weeks to develop, build, and sell H2 model car in "shark tank" PBL lesson as part of NJ Transit competition or conduct an in class solar engineering competition depending on resource availability and time.

Teacher's Notes:
This unit is very much based on media and reading for information. The Fuel Cell Car competition or a similar solar engineering task will likely utilize most of the lab time.

6. **Pollution**
Describe sources of air, water, noise, and waste pollution and their impact on ecosystems. Describe strategies for reduction and remediation of pollutants. Describe the impact of various pollutants on human and ecosystem health. Assess current legislations and initiatives targeted at both consumers and industry.
Standards Covered:
Science Standards: HS-LS1-3; HS-LS2-2; HS-LS2-7; HS-ESS3-4;
ELA Standards: RST.11-12.1; RST.11-12.2**; SL.11-12.5;** WHST.9-12.2;
Math Standards: **HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.B.6;**

21st Century Standards: **CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.**

Suggested Activities:

a. Air pollution and vehicle emissions lab
b. Water quality lab - students will use water quality testing kit to assess quality of a variety of water sources.
c. Wastewater treatment lab (kit from Carolina).
d. Tour of wastewater treatment plant.
e. Ocean acidification lab - may use Acid Test from NOAA as a resource for student engagement and experiment planning.
f. Plastic pollution research project and art installation - after researching (or watching a film) about plastics and pollution, students will write a position essay based on their findings then generate a visual exhibit to support their stance.
g. "Water in Weberville" toxicity case study.
h. LD50 student designed lab - may use seeds, brine shrimp, or other microorganism depending on toxins studied.
i. Student designed noise pollution lab.

Teacher's Notes:

Much of this unit depends on the resources available at the time. There are many opportunities for local/quick lab period field trips (wastewater treatment, sanitation department, etc).

7. **Global Change**

Describe how human activities have impacted stratospheric ozone. Describe how emissions, particularly carbon emissions relate to global climate change and analyze human involvement in this process. Describe how loss of biodiversity impacts life on Earth. Analyze how legislation impacts the above issues and the role of the United Nations or international forces in addressing global environmental issues.

Standards Covered:

Science Standards: HS-ESS2-6; HS-ESS3-1; HS-ESS3-3; HS-LS4-5; HS-LS4-6;
ELA Standards: **RST.11-12.1; RST.11-12.2; SL.11-12.5;**WHST.9-12.2; WHST.9-12.7;
Technology Standards: 8.1.12.E.1;
Math Standards: **HSN-Q.A.1; HSN-Q.A.2; HSN-Q.A.3; HSS-IC.B.6;**
21st Century Standards: **CRP1, 2, 6, 7, 8, 11, 12, 9.2.12.C.3, 9.2.12.C.4, 9.2.12.C.7.**

Suggested Activities:

a. Small group discussion regarding definitions of "economic health", "natural capital", and "basic human welfare" after listening to podcast excerpts (choice of following): Planet Money Episode 6 The Bottom of the Well (California almond farming), Freakonomics Radio: Confessions of a Pothole Politician (2016) (listen 26:35-31:40 LA/Persuasion), Only Human: I Thought the Truth Would Be Enough (2016) (listen 13:35-25:29 re Flint/Integrity/Whistleblower).
b. Climate change in a jar lab
c. Lab: Investigating Legislation Kit (Carolina) - explore environmental laws and regulations (Clean Air and Clean Water Acts) by investigating the effects of nitrogen dioxide on plants and performing an LD50 (lethal dose 50%) of a water pollutant on a population of brine shrimp FR MG 66: Regulations and Equity (Ch.20, pp.711-720)

d. Compare Cap and Trade to Paris agreement - predict success of commitments in US v. India - what are the factors determining potential success?
e. Watch excerpts from Gasland and listen to excerpts from Planet Money Buys Oil (NPR) - discuss trade off of economic benefits of inexpensive oil and risks to clean water.
f. Field Invasive Species School Grounds Tour - Identify invasive and non-invasive species around the campus. Propose reasons why these species are present and discuss the potential ecological impact that invasive species might have. Conduct additional research on invasive species and evaluate the ecological and human health risks associated with these species. Propose possible solutions on the local and global scale
g. Class Debate: excerpts from Racing Extinction - why is biodiversity important? What is the cost of preserving it and is it worthwhile? What methods work? What about preventing the loss by preserving habitat? Research and compare methods of preserving biodiversity (removing rhino horns, farming corals, etc).

Teacher's Notes:

This unit is based on current events and a great place to use discussion, current event homework assignments/ a current events scrapbook, etc. It also serves as a good segue to review and integrate all of the previous topics.